

PCA Rogers Pass Washroom Facility

Glacier National Park, British Columbia

Project Manual

ISSUED FOR BID

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Prepared by



riddell kurczaba

architecture engineering interior design ltd.

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Part 1 General

1.1 BACKGROUND

- .1 The closure of the commercial accommodation facility at Rogers Pass in late 2012, and closure of washrooms at the adjoining service station the previous year, resulted in the transfer of demand for year-round, 24-hour washrooms from the former lease properties to Parks Canada.
- .2 Over 4 million people travel the highway each year and thousands of travelers can easily be delayed at Rogers Pass during a day of highway closures. Temporary washrooms that are housed in trailers have been installed on site to accommodate the needs to travelers.
- .3 Parks Canada is planning to replace the temporary washrooms and construct a year-round washroom building at the summit of Rogers Pass in Glacier National Park, British Columbia. The washroom facility will be surrounded by a parking lot and day use area.
- .4 The building itself has to be designed to have 17 washroom units of which 5 are handicapped accessible and family washrooms. Besides the prime function the facility program includes a gathering space to accommodate 40 people, partially with seating arrangements which are not included as part of this contract
- .5 The surrounding day use area will achieve low maintenance, and provide a robust environment that can stand high traffic areas.
- .6 The site was previously remediated for soil contamination and demolition of a service station in late 2018. All excavations have been backfilled and the site has been leveled. Site photos are shown in Appendix B and available geotechnical information from the site remediation is shown in Appendix C.

1.2 WORK COVERED BY CONTRACT DOCUMENTS

- .1 Work of this Bid Package comprises general construction of PCA Rogers Pass Washroom Facility, located at Rogers Pass, British Columbia. Work of this package includes the construction of the building and related sitework.
- .2 Scope of Work includes:
 - .1 Washroom Facility
 - .2 Site Utilities
 - .3 Site Landscaping
 - .4 Parking Lot
 - .5 Site Preparation
- .3 Work specified in Specifications is divided into Divisions and Sections for reference purposes only. Except as may be otherwise specified in Bid Document, division of work among Contractor, Subcontractors, Sub-subcontractors and suppliers is Bidders' responsibility

1.3 CONTRACT METHOD

- .1 Construct Work under single stipulated price contract.

1.4 PRECEDENCE

- .1 For Federal Government projects, Division 1 Sections take precedence over technical specifications and specification sections in other Divisions of this Project Manual.
- .2 The most current revision of codes and standards referenced in this project manual shall be used unless specifically noted otherwise.

1.5 WORK SCHEDULE

- .1 Contractor shall prepare a Project Execution Plan showing proposed baseline construction schedule, subsequent schedules shall have the baseline schedule shown for comparison.
- .2 When Project Execution Plan has been approved by Departmental Representative, take necessary measures to complete work within scheduled time. Do not change without Departmental Approval.

1.6 MILESTONE DATES

- .1 Anticipated Start Date: May 1, 2019*
- .2 Substantial Completion: February 1, 2020
- .3 Total Completion: March 31, 2020
- .4 Contractor can conduct work prior to May 1, however the Contractor will need to get approval from Parks Canada prior to starting. Any additional costs associated with an early start date (e.g. snow removal, additional environmental protection requirements, etc. will be borne by the Contractor.

1.7 WORK BY OTHERS

- .1 Co-operate with other Contractors in carrying out their respective works and carry out instructions from Departmental Representative.
- .2 Co-ordinate work with that of other Contractors. If any part of work under this Contract depends for its proper execution or result upon work of another Contractor, report promptly to Departmental Representative, in writing, any defects which may interfere with proper execution of Work.
- .3 Work of Project executed during Work of this Contract, and which is specifically excluded from this Contract:
 - .1 Furniture including - television, phones, vending machines, and furniture for sitting purposes.
- .4 Other contractors may be working in Glacier National Park and Rogers Pass National Historic Site. The Contractor shall coordinate his operations with others. No claims for any delays, lost profit or inconvenience will be entertained. The current known projects for the 2019 season include, but are not limited to:
 - .1 East Gate Landslide Hauling Km 3.0 – 4.1
 - .2 Beaver Valley Vehicle Ponding, Km 5.5 – 7.1
 - .3 Culvert installations Km 5.5 and Km 8.1
 - .4 Beaver Hill Rock Scaling Km 12 – 15
 - .5 Snowshed Drainage Works, Km 16.5 – 20.0
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- .7 Avalanche Mitigation Mounds, Km 19.8 – 20.1
 - .8 Trans-Canada Highway Widening, Km 20 – 26
 - .9 Parks Canada Operations Compound Stormwater Works, Rogers Pass
 - .10 Site Restoration of former Glacier Park Lodge Site and Groundwater Well Maintenance, Rogers Pass
 - .11 Cougar Creek Corner Catchment Cleaning, Km 31.7 – 33.4
 - .12 Line painting, various locations
 - .13 Other projects and maintenance work may occur along the TCH in 2019 and 2020.
- .5 The Contractor shall coordinate work of this contract with the work done by other contractors on or near the work area as required.

1.8 WORK SEQUENCE

- .1 Co-ordinate Progress Schedule.
- .2 Maintain fire access/control.

1.9 CONTRACTOR USE OF PREMISES

- .1 Unrestricted use of site until Substantial Performance.
- .2 Limit use of premises for Work, for storage, and for access, to allow:
 - .1 Work by other contractors.
- .3 Co-ordinate use of premises under direction of Departmental Representative.
- .4 Obtain and pay for use of additional storage or work areas needed for operations under this Contract.
- .5 Remove or alter existing work to prevent injury or damage to portions of existing work which remain.
- .6 Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as directed by Departmental Representative.
- .7 At completion of operations condition of existing work: equal to or better than that which existed before new work started.
- .8 For the purpose of this contract, Contractor will not be permitted to set up camp or otherwise occupy space in Glacier National Park.
- .9 Parks Canada regulations prohibit anyone working with the Park from using campground facilities.

1.10 NATIONAL PARK REGULATIONS

- .1 Contractor and all sub-contractors shall ensure that all work is performed in accordance with ordinances, laws, rules and regulations set out in the National Park Act.

- .2 Contractor and all sub-contractors shall obtain business licenses from Parks Canada Administration Office prior to commencement of work.
- .3 Contractor and all sub-contractors shall comply with all laws and government regulations applicable to work under this contract.
- .4 All Contractor's and all sub-contractor's business and private vehicles are required to obtain vehicle passes from Parks Canada Administration Office.
- .5 Contractor to equip all service vehicles and supervisory vehicles with Emergency Spill Kit DOT-E-10102 or equivalent.
- .6 Contractor is responsible to ensure all sub-contractors comply with ordinances, laws, rules and regulations set out in the National Park Act.

1.11 DOCUMENTS REQUIRED

- .1 Maintain at job site, one copy each document as follows:
 - .1 Contract Drawings.
 - .2 Specifications.
 - .3 Addenda.
 - .4 Reviewed Shop Drawings.
 - .5 List of Outstanding Shop Drawings.
 - .6 Change Orders.
 - .7 Other Modifications to Contract.
 - .8 Field Test Reports.
 - .9 Permits
 - .10 Copy of Approved Work Schedule.
 - .11 Health and Safety Plan and Other Safety Related Documents.
 - .12 Other documents as specified.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 ACCESS AND EGRESS

- .1 Design, construct and maintain temporary "access to" and "egress from" work areas, including stairs, ramps or ladders and scaffolding, independent of finished surfaces and in accordance with relevant municipal, provincial and other regulations.

1.2 USE OF SITE AND FACILITIES

- .1 Execute work with least possible interference or disturbance to normal use of premises. Make arrangements with Departmental Representative to facilitate work as stated.
- .2 Maintain existing services to building and provide for personnel and vehicle access.
- .3 Where security is reduced by work provide temporary means to maintain security.
- .4 Closures: protect work temporarily until permanent enclosures are completed.
- .5 The Contractor may work from Monday to Sunday from 7AM to 7PM. Work may be completed outside of these times with approval from Department Representative.

1.3 EXISTING SERVICES

- .1 Notify Departmental Representative and utility companies of intended interruption of services and obtain required permission.
- .2 Where Work involves breaking into or connecting to existing services, give Departmental Representative 48 hours of notice for necessary interruption of mechanical or electrical service throughout course of work. Minimize duration of interruptions. Carry out work at times as directed by governing authorities with minimum disturbance to pedestrian and vehicular traffic.
- .3 Provide alternative routes for pedestrian and vehicular traffic.
- .4 Establish location and extent of service lines in area of work before starting Work. Notify Departmental Representative of findings.
- .5 Submit schedule to and obtain approval from Departmental Representative for any shut-down or closure of active service or facility including power and communications services. Adhere to approved schedule and provide notice to affected parties.
- .6 Provide adequate bridging over trenches which cross sidewalks or roads to permit normal traffic.
- .7 Where unknown services are encountered, immediately advise Departmental Representative and confirm findings in writing.
- .8 Protect, relocate or maintain existing active services. When inactive services are encountered, cap off in manner approved by authorities having jurisdiction.
- .9 Record locations of maintained, re-routed and abandoned service lines.
- .10 Construct barriers in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.

1.4 SPECIAL REQUIREMENTS

- .1 Carry out excessive noise generating work Monday to Friday from 18:00 to 07:00 hours and not on Saturdays, Sundays and statutory holidays.
- .2 Submit schedule in accordance with Section 01 32 16 – Construction Schedule.
- .3 Ensure that Contractor personnel employed on site become familiar with and obey regulations including safety, fire, traffic and security regulations.
- .4 Keep within limits of work and avenues of ingress and egress.
- .5 Ingress and egress of Contractor vehicles at site is limited to location as directed.

1.5 SECURITY CLEARANCES

- .1 Personnel employed on this project will be subject to security check. Obtain clearance, as instructed, for each individual who will require to enter premises.
- .2 Personnel will be checked daily at start of work shift and provided with pass which must be worn at all times. Pass must be returned at end of work shift and personnel checked out.

1.6 USE OF PUBLIC AREAS

- .1 The Contractor shall ensure that its vehicles and equipment do not cause nuisance in public areas. All vehicles and equipment leaving the Work Site and entering public roadways shall be cleaned of mud and dirt clinging to the body and wheels of the vehicle.
- .2 All vehicles arriving at or leaving the Work Site and transporting materials shall be loaded in a manner which will prevent dropping of materials or debris on the roadways, and, where contents may otherwise be blown off during transit, such loads shall be covered by tarpaulins or other suitable covers. Spills of material, including rocks and debris from loaded trucks, shall be removed or cleaned immediately by the Contractor at no cost to the Owner. All activities shall be in accordance with Section 01 35 43 Environmental Procedures and the Environmental Protection Plan prepared by the contractor for the project. Hauling units on public highways shall not to exceed legal highway load limits.
- .3 The Contractor is responsible for ensuring all equipment accessing the Highway meets all requirements for vehicles traveling on Public Highways in the Province.

1.7 BUILDING SMOKING ENVIRONMENT

- .1 Smoking is not allowed.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 General Conditions and Project Supplementary Conditions

1.2 PRIME COST SUM

- .1 Include in Contract Price a total Prime Cost Sum of: \$250,000.00
- .2 Do not include in the Contract Price, additional contingency allowances for products, installation, overhead or profit.
- .3 Prime Cost Sum provided for in the Lump Sum Arrangement Table is not a sum due to the Contractor. Rather, payment will be made against it for miscellaneous work not included in the unit price table under the General Conditions of the Contract.
- .4 No interpretation of the items listed under Prime Cost Sum Allowances shall indicate that work will be included under the Prime Cost Sum. Items, tasks, and activities included in the Works elsewhere in the Contract, including Unit price and Lump Sum Items, shall be paid as indicated in those sections and not under the Prime Cost Sum.
- .5 Any and all additional work must be approved in writing by the Departmental Representative prior to commencement.
- .6 All expenditures must be substantiated with verified invoices and/or accepted daily extra work reports as noted in Measurement and Payment Procedures below.
- .7 The intent for this item is to pay for unforeseen extra work that is not identified in this Contract. Unforeseen work may include, but it not limited to the following:
 - .1 Alterations to excavations and earthworks boundaries;
 - .2 Unforeseen site conditions prior to construction leading to additional site selective demolition;
 - .3 Changes in the building, civil, site utilities, or landscaping design related to unforeseen site conditions;
 - .4 Site contamination and/or dewatering;
 - .5 Archaeological finds; and
 - .6 Miscellaneous work not included in the unit price table under the General Conditions of the Contract
- .8 The Contract Price, and not Prime Cost Sum, includes Contractor's overhead and profit in connection with the Work.

1.3 MEASUREMENT PROCEDURES

- .1 Payment for Work under the “**Lump Sum Price Item 3 - Prime Cost Sum**” will be made using negotiated rates or by material, labour and equipment rates as per the following:
- .2 Rental rates will be in accordance with current B.C. Roadbuilders & Heavy Construction Association's rate schedule, and will be all inclusive and fully operated.

- .3 Vehicles (ie. Pickup trucks) will be paid either at daily rates as per the B.C. Roadbuilders & Heavy Construction Association's or by mileage using National Joint Council (NJC) rates. The Contractor will not be permitted to claim both daily rental and mileage rates.
- .4 Hourly rental of equipment will be measured in actual working time and necessary travel time within project limits. Transportation time to and from site to be reimbursed only if equipment is used exclusively for additional work.
- .5 Equipment paid on standby will be paid on 50% of the relevant Less Operator rates to a maximum of 10 hrs per day.
- .6 When based upon actual costs for additional works under Prime Cost Sum, payment will be based upon supplied invoices and other work records.
- .7 The Prime Contractor may apply a 10% mark-up to subcontractor or supplier invoices only, as accepted by the Departmental Representative. No mark-up will be allowed on relevant equipment and labour rates.
- .8 A claim for additional payment will be considered submitted when all required documentation has been received by the Departmental Representative.
- .9 The Departmental Representative's signature on extra work reports is an agreement to the hours worked that day. Labour and equipment rates are to be reviewed by the Departmental Representative against the appropriate accepted rates when submitted for payment.

Part 2 Products

- .1 Products shall be in accordance with the stated specification's current standard.

Part 3 Execution

- .1 Work shall be in accordance with the stated specification's current standard.

END OF SECTION

Part 1 General

1.1 MEASUREMENT AND PAYMENT - GENERAL

- .1 Payments will be made based on the lump sum prices bid and the unit prices bid in the Tender, and in accordance with the Terms and Conditions of the Contract.
- .2 The prices bid for various items of work, unless specifically noted otherwise, shall include the supply of all labour, material, plant, equipment, profit and overhead necessary to construct the work in accordance with the drawings and specifications.
- .3 The prices bid for supply of materials and installation of materials unless specifically noted in the Schedule of Prices and shall be full compensation of supplying, hauling, installing, cleaning, testing, and placing in service together with all other work subsidiary and incidental thereto for which separate payment is not provided elsewhere.
- .4 The method of measurement of the quantities for payment and the basis for payment will be in accordance with the following items of this section. The Contractor is responsible for all measurement, using generally accepted field survey methods and will be verified by the Departmental Representative.
- .5 All materials on site whether existing structures, vegetation, topsoil, gravel, sand or other excavated, or piled materials are the property of the Owner or the owner of the land on which the work is located. Only those materials specifically noted in the specification or on drawings as belonging to the Contractor shall become the Contractor's property.
- .6 Where there are excess excavated materials, unsuitable materials excavated or materials of any kind that are excavated but not used in the work, such materials are not the property of the Contractor unless authorized in writing by the Departmental Representative or specified to be disposed of by the Contractor.
- .7 Each unit price shall be the full and only amount payable for the unit and all things directly or indirectly required to complete it in accordance with the contract, such as, but not limited to delivering, erecting, handling, re-handling, storing, consumable items, temporary facilities, scaffolding, protecting, painting, setting out, disposing, clean up, measuring, calculating, scheduling, administration, supervising, inspection, testing, overhead, profit and ancillary/incidental items thereto for which separate payment is not elsewhere provided.
- .8 Each item will be measured for payment in the unit stated in the Schedule of Prices. The unit prices in the Schedule shall remain unchanged notwithstanding differences between the actual quantities and quantities shown herein.
- .9 The items listed in the Schedule of Prices shall, when all considered together, cover the entire Scope of the Work required by the Tender Documents at the time of tendering. The scope of each item is, and shall be, interpreted accordingly.

Part 2 Products

2.1 WASHROOM BUILDING (Item 1)

- .1 The lump sum prices in Section A of the Schedule of Prices will include all costs associated with the item described and will be full compensation for all materials, labour and equipment required for these lump sum items.
- .2 Measurement: The Owner will base payment for this lump sum item on a percentage of work completed in dollars.
- .3 Payment: Lump Sum price bid.

2.2 GENERAL REQUIREMENTS (Item 2)

- .1 This Lump Sum Price will include all costs associated in mobilizing, maintaining, and demobilizing the site, required to execute the work including:
 - .1 Specified insurance, equipment, operating overhead, mobilization, and demobilization costs required to maintain the workforce on site.
 - .2 Provide the necessary bonds, permits and business licence.
 - .3 Safeguarding work areas including safety program, provision of temporary access roadways, temporary paths, temporary barriers, delineators, barricades, flashing lights, signage, flagmen and other measures required to protect the public from the worksite and to provide access at intersecting streets, including maintenance of such items. Note that fencing and signage protecting the construction site from public access is to be included in General Requirements.
 - .4 Temporary material storage and handling.
 - .5 Maintenance of stockpile and material conditioning sites including restoration.
 - .6 Installation of project signs supplied by Owner.
 - .7 Notification of BCOneCall and other private sources necessary to obtain all underground utility locations.
 - .8 Location of existing utilities by Hydro-vacung or other approved means.
 - .9 Accommodation of vehicle and pedestrian traffic affected by the work, including planning, signage, temporary pavement markings, barricades, traffic control and public notification.
 - .10 Environmental management as required in the contract documents.
 - .11 Dust and sediment control throughout the project duration.
 - .12 Assume role and responsibility of Prime Contractor under the Workers Compensation Health and Safety Act.
 - .13 Construction Survey requirements including all labour, materials and coordination required to complete Construction Surveys for the Project.
 - .14 Materials Testing and Quality Control as specified in Section 01 45 00 – Quality Control.
 - .15 Supply, maintenance, and utility costs for field offices as specified in Section 01 52 00 – Construction Facilities.
 - .16 The Contractor's responsibilities and requirements as outlined in all specification sections which are not included elsewhere.

- .2 Measurement: The Owner will base payment for this lump sum item on a percentage of work completed in dollars.
- .3 Payment: Lump Sum price bid.

2.3 PRIME COST SUM (Item 3)

- .1 The Prime Cost Sum information is shown under Section 01 21 00 "Allowances".
- .2 Measurement and payment: All expenditures must be substantiated with verified invoices and/or accepted daily extra work reports as noted in Measurement and Payment Procedures below.

2.4 ASPHALT REMOVAL (Item 4.1)

- .1 The price shall be full compensation for all labour and equipment required to mill existing asphalt to full depth. Milled material shall be stock piled and will become property of Parks Canada.
- .2 Measurement: Removal will be measured in square meters of full depth milling.
- .3 Payment: Payment will be made at the unit price for each square meter milled to full depth.

2.5 SUBGRADE PREPARATION FOR ASPHALT AND CONCRETE (Item 4.2)

- .1 The Unit Price for subgrade preparation shall be full compensation for excavation, temporary stockpiling, and double handling, scarifying, mixing, moisture conditioning rolling, spreading, shaping and compacting to the specified depths and density.
- .2 Measurement: Field measured in cubic metres of the subgrade preparation neat line areas before granular sub-base placement. No payment will be made for subgrade preparation completed outside the specified limits.
- .3 Payment: Unit price bid per cubic meter which shall be full compensation for all labour, materials, and equipment necessary to complete the work.

2.6 COMMON EXCAVATION (Item 5.1 and 5.2)

- .1 Common Excavation will include excavation of all existing materials to the design grade elevations required within the construction area. Excavated materials will be disposed outside of the National Park in an approved disposal location. There shall be no additional compensation for overhaul or spreading at approved location.
- .2 Measurement: Cubic metres determined by survey of excavated area cross-sectioned before and after excavation.
- .3 Payment: Unit price bid per cubic meter excavated which shall be full compensation for all labour, materials, and equipment necessary to complete the work.

2.7 ENGINEERED FILL – PIT RUN 75mm MINUS (Item 6.1 and 6.2)

- .1 The Unit Price for these items shall be full compensation for supply, hauling, placement, spreading, shaping and compaction of pit run gravel as determined by the Departmental Representative to bring construction to sub-grade design elevations in the areas identified in the contract documents.
- .2 Measurement: Truck slips delivered to the Departmental Representative with the actual tonnage, date of delivery, type of material. No payment will be made for material without the appropriate truck slip.
- .3 Payment: Unit price bid per metric tonnes by weighed truck slip will be full compensation for all labour, materials, and equipment necessary to complete the work.

2.8 LANDSCAPED BERM (Item 6.3)

- .1 The Unit Price for these items shall be full compensation for supply, hauling, placement, spreading, shaping and compaction of common fill as determined by the Departmental Representative to bring construction to required design elevations.
- .2 Measurement: Cubic metres determined by survey of excavated area cross-sectioned before and after site preparation.
- .3 Payment: Unit price bid per cubic meter excavate placed which shall be full compensation for all labour, materials, and equipment necessary to complete the work.

2.9 ASPHALT AND CONCRETE SUBGRADES (Item 7.1 and 7.2)

- .1 The Unit Price for subgrade preparation shall be full compensation for excavation, temporary stockpiling, and double handling, scarifying, mixing, moisture conditioning rolling, spreading, shaping and compacting to the specified depths and density.
- .2 Measurement: Field measured in cubic metres of the subgrade preparation neat line areas before granular sub-base placement. No payment will be made for subgrade preparation completed outside the specified limits.
- .3 Payment: Unit price bid per cubic meter which shall be full compensation for all labour, materials, and equipment necessary to complete the work.

2.10 BASE COURSE AND ASPHALT SURFACE (Items 7.3, 7.4, 7.5)

- .1 The Unit Price for these items shall be full compensation for supply, hauling, placement, spreading, shaping and compaction in the area described in the Schedule of Prices to the specified depths and density.
- .2 Measurement: Truck slips delivered to the Departmental Representative with the actual tonnage, date of delivery, type of material. No payment will be made for material without the appropriate truck slip.
- .3 Payment: Unit price bid per metric tonnes by weighed truck slip will be full compensation for all labour, materials, and equipment necessary to complete the work.

2.11 SURFACES – CONCRETE SIDEWALKS AND PLAZA (Item 7.6)

- .1 Work includes the supply and installation of the concrete surface, reinforcement, erection of formwork and false work as necessary, clean up, hauling and mixing of concrete materials, and any incidentals related to the work. Work also includes all required finishing as indicated on contract drawings and specifications.
- .2 Measurement for payment shall be made for supply and installation in square meters that is completed and approved by the Departmental Representative.
- .3 Payment: Unit price bid per square metre installed.

2.12 CONCRETE CURB AND GUTTER (Item 7.7)

- .1 Work includes the supply and installation of concrete, reinforcement, erection of formwork and false work as necessary, clean up, hauling and mixing of concrete materials, and any incidentals related to the work. Concrete surface work can be hand formed or extruded. No separate payment will be made for the method chosen by the contractor.
- .2 Measurement for payment shall be made for supply and installation in linear metres down the centreline of the curb that is completed and approved by the Departmental Representative.
- .3 Payment: Unit price bid per linear metre installed.

2.13 CONCRETE PAD FOR PROPANE TANK (Item 7.8)

- .1 Work includes the supply and installation of the concrete surface, reinforcement, erection of formwork and false work as necessary, clean up, hauling and mixing of concrete materials, and any incidentals related to the work. Work also includes all required finishing as indicated on contract drawings and specifications.
- .2 Measurement for payment shall be made for supply and installation in square meters that is completed and approved by the Departmental Representative.
- .3 Payment: Unit price bid per square metre installed.

2.14 CRUSHED ROCK PATHWAY (Item 7.9)

- .1 The Unit Price for these items shall be full compensation for supply, hauling, placement, spreading, shaping and compaction of specified crushed rock as determined by the Departmental Representative.
- .2 Measurement: Truck slips delivered to the Departmental Representative with the actual tonnage, date of delivery, type of material. No payment will be made for material without the appropriate truck slip.
- .3 Payment: Unit price bid per metric tonnes by weighed truck slip will be full compensation for all labour, materials, and equipment necessary to complete the work.

2.15 PAINTED LINES (Item 7.10)

- .1 Work includes the required painted lines and pavement markings on the final pavement surface as indicated on per the Contract documents or as requested by the Departmental Representative. Work includes all labour, equipment and material to satisfactorily complete this item.
- .2 Measurement: The Owner will base payment for this lump sum item on a percentage of work completed in dollars.
- .3 Payment: Lump Sum price bid.

2.16 LANDSCAPING – PLANT MATERIAL (Item 8.1)

- .1 The Unit Price shall be full compensation for the supply and installation of all trees, shrubs or ground covers in accordance with the drawings and specifications. The Unit Price shall include all work incidental to the supply and installation.
- .2 Measurement: Measured for total amount of trees, shrubs or ground covers as installed.
- .3 Payment: Lump sum for trees, shrubs or ground covers installed.

2.17 LANDSCAPING – TOPSOIL (Item 8.2)

- .1 The Unit Price shall be full compensation for supply and install of approved topsoil. Price includes loading, hauling, spreading, trimming, and shaping to the depth specified.
- .2 Measurement: Cubic metres determined by survey of stockpile cross-sections before and after placement.
- .3 Payment: Unit price bid per cubic meter placed which shall be full compensation for all labour, materials, and equipment necessary to complete the work.

2.18 LANDSCAPING – ESTABLISH LANDSCAPE MAINTENANCE (Item 8.3)

- .1 The Lump Sum price shall be full compensation for the maintenance of all landscape items in accordance with the specifications. The Lump Sum Price shall include all work incidental to the maintenance identified in the contract documents.
- .2 Measurement: When all Landscape Items have been installed and substantial completion has been awarded.
- .3 Payment: The Lump Sum price will be paid after all Landscape items have been completed and Substantial Completion has been awarded.

2.19 LANDSCAPING – ALUMINUM EDGER (Item 8.4)

- .1 The lineal meter price shall be full compensation for trenching and backfilling to accommodate aluminium edger as shown on the contract drawings. The lineal meter price shall include the supply, installation, shipping, excavation, backfill and compaction.
- .2 Measurement: Measured in lineal meters of aluminum edger installed.
- .3 Payment: Unit rate bid price per lineal meter of aluminum edger installed.

2.20 SUPPLY AND INSTALL SOD AND SEEDING (Items 8.5 and 8.6)

- .1 The Unit Price shall be full compensation for sodded/seeded over the areas identified in the contract documents. Price includes seed, placement to the contract specifications. No payment will be made for seeding completed outside the specified limits. Contractor to provide seed mix and Departmental Representative to approve.
- .2 Measurement: Field measured in horizontal square metres of areas seeded/sodded.
- .3 Payment: Unit price bid per horizontal square meter which shall be full compensation for all labour, materials, and equipment necessary to complete the work.

2.21 SUPPLY AND INSTALL POWER LINE (Items 9.1)

- .1 The lineal meter price shall be full compensation for the supply and installation of various diameters and type of conduits and power lines, in accordance with the project drawings and specifications. The lineal meter price shall include the excavation (all depths), bedding, backfill and compaction. Work should also include all necessary connections and related appurtenances required for the completion of the power connection to the proposed building.
- .2 Measurement: Measured in lineal meters of power conduit and power line installed.
- .3 Payment: Unit rate bid price per lineal meter of power conduit and power line installed.

2.22 SUPPLY AND INSTALL WATER LINE (Items 9.2)

- .1 The lineal meter price shall be full compensation for the supply and installation of various diameters and type of pipes, in accordance with the project drawings and specifications. The lineal meter price shall include the excavation (all depths), bedding, backfill and compaction. Work includes all required connections to existing infrastructure.
- .2 Measurement: Measured in lineal meters of pipe installed.
- .3 Payment: Unit rate bid price per lineal meter of pipe installed.

2.23 SUPPLY AND INSTALL SANITARY LINE (Items 9.3)

- .1 The lineal meter price shall be full compensation for the supply and installation of various diameters and type of pipes, in accordance with the project drawings and specifications. The lineal meter price shall include the excavation (all depths), bedding, backfill and compaction. Work includes all required connections to existing infrastructure.
- .2 Measurement: Measured in lineal meters of pipe installed.
- .3 Payment: Unit rate bid price per lineal meter of pipe installed.

2.24 SUPPLY AND INSTALL COMMUNICATIONS LINE (Items 9.4)

- .1 The lineal meter price shall be full compensation for the supply and installation of various diameters and type of pipes, in accordance with the project drawings and specifications. The lineal meter price shall include the excavation (all depths),

bedding, backfill and compaction. Work should also include all necessary connections and related appurtenances required for the completion of the power connection to the proposed building.

- .2 Measurement: Measured in lineal meters of conduit and communication lines installed.
- .3 Payment: Unit rate bid price per lineal meter of conduit and communication lines installed.

2.25 SUPPLY AND INSTALL LIGHT STANDARD (Item 9.5)

- .1 Measurement for payment for supply and installation of light standards complete with required power connections will be based on each complete unit installed according to these specifications, and shall include all labour, equipment and materials to satisfactorily complete this item of work. Payment shall be full compensation for the supply of all materials, lighting, poles, bases, excavation, trenching, back filling, compaction, wiring, grounding, installation and any incidentals required to complete the work in accordance with these specifications and the contract drawing, to the satisfaction of the Departmental Representative.
- .2 Measurement: Lump Sum for supply and installation per light standard and associated cable and wiring as shown on contract documents and specifications based on percentage completed of full commissioning.
- .3 Payment: Lump sum item.

2.26 SUPPLY AND INSTALL PROPANE TANK (Item 9.6)

- .1 Supply and installation of propane tank complete with required connections to the building will be based on each complete unit installed according to these specifications, and shall include all labour, equipment and materials to satisfactorily complete this item of work. Work includes all excavation, trenching, back filling, compaction, wiring, grounding, installation and any incidentals required to complete the work to the satisfaction of the Departmental Representative. Work also includes any required commissioning and testing as per specifications.
- .2 Measurement: Lump Sum for supply and installation per light standard and associated cable and wiring as shown on contract documents and specifications based on percentage completed of full commissioning.
- .3 Payment: Lump sum item.

2.27 INSTALL ONLY 450 HDPE STORMWATER PIPE (Item 9.7)

- .1 The lineal meter price shall be full compensation for the installation of Parks Canada supplied HDPE stormwater pipe in accordance with project drawings and specifications. The lineal meter price shall include the excavation, bedding, backfill and compaction. Work includes all required connections to existing and proposed infrastructure.
- .2 Measurement: Measured in lineal meters of pipe installed.
- .3 Payment: Unit rate bid price per lineal meter of pipe installed.

2.28 INSTALL ONLY STORMWATER SUMP C/W RIPRAP (Item 9.8)

- .1 The Unit Price shall be full compensation for the installation of the Parks Canada supplied stormwater sump and related connections and appurtenances in accordance with the project drawings and specifications. The Unit Price shall include the excavation (all depths), bedding, backfill and compaction. Riprap should be incidental to this unit price item.
- .2 Measurement: Measured individually as each appurtenance is installed.
- .3 Payment: Unit rate bid price per each appurtenance installed.

2.29 SUPPLY AND INSTALL CMP CULVERT (Item 9.9)

- .1 The Unit Price shall be full compensation for supply and installation of CSP culverts, in accordance with project drawings and specifications. This unit price shall be full compensation for the installation of the culverts, in accordance with project drawings and specifications, including preparation, bedding, compaction, and back fill.
- .2 Measurement: Measured in lineal meter of CSP diameter culvert installed.
- .3 Payment: Unit Price bid based on the lineal meter per diameter of culvert unit price bid.

2.30 SUPPLY AND INSTALL SANITARY MANHOLES (Item 9.10)

- .1 The Unit Price shall be full compensation for the supply and installation of sanitary manholes and related connections and appurtenances in accordance with the project drawings and specifications. The Unit Price shall include the excavation (all depths), bedding, backfill and compaction.
- .2 Measurement: Measured individually as each appurtenance is installed.
- .3 Payment: Unit rate bid price per each appurtenance installed.

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Coordinate between mechanical and electrical work, and work of other affected Sections in accordance with the requirements of this Section and other affected sections.

1.2 RELATED SECTIONS

- .1 Section 03 11 00 – Concrete Forming: Placement of cut outs and sleeves.
- .2 Section 07 84 00 – Firestopping and Smoke seals
- .3 Divisions 21, 22 and 23 – Common Work Results: Common work results for fire suppression, plumbing, and heating, ventilating and air conditioning systems
- .4 Division 25 – Common Work Results: Common work results for integrated automation.
- .5 Divisions 26, 27 and 28 – Common Work Results: Common work results for electrical, communications, and electronic safety and security.
- .6 Section 26 50 00 – Lighting: Coordination of lighting installation with other mechanical and electrical systems.

1.3 MECHANICAL-ELECTRICAL WORK COORDINATOR

- .1 Contractor shall be responsible for providing a person technically qualified and experienced in field coordination for the type of mechanical and electrical work required for this Project, for duration of construction work.
- .2 Mechanical and Electrical Coordination shall be performed by a dedicated person other than the Contractor's Project Manager; who shall have experience with coordinating complex mechanical and electrical work and shall be acceptable to the Departmental Representative or Owner.

1.4 SUBMITTALS

- .1 Provide required coordination documents before submitting shop drawings, product data and samples; provide information required by this Section in accordance with Section 01 33 00.
- .2 Preparation of Mechanical and Electrical Coordination Drawings specified in this Section form a part of the Contractor's Submission requirements and are specifically excluded from the Mechanical and Electrical Subcontractor's Scope-of-Work as follows:
 - .1 Mechanical and Electrical Subcontractors shall allow for full assistance and cooperation with the General Contractor in the provision of all required information for the assembly of Coordination Drawings.
 - .2 Mechanical and Electrical Coordination Drawings described in this Section form a part of the General Contractor's Scope-of-Work.
- .3 Departmental Representative reserves the right to reject any candidate that does not appear suitable for this Project.

- .4 Submit field coordination drawings for mechanical and electrical work above ceilings for all floor levels, including penthouse and mechanical and electrical rooms, supplemented with building cross sections indicating mechanical and electrical systems fully coordinated with structural drawings and details, and coordinated with architectural finish components such as ceilings, bulkheads, furring, casework and equipment, indicating ductwork, piping, conduit, and equipment in their intended locations, coordinated with all other parts of the Work and highlighting potential interference between systems and building components.

Part 2 Products

2.1 COORDINATION DOCUMENTS

- .1 Prepare Field Coordination Plan and Section Drawings indicating coordination for the following:
 - .1 Installation of subgrade plumbing work.
 - .2 Installation of above ceiling mechanical and electrical work coordinated with the structure and architectural ceiling heights for efficient use of available space, for proper sequence of installation, and to resolve interferences.
 - .3 Scale:
 - .1 Plans: Not less than 1:50 metric.
 - .2 Sections: Not less than 1:20 metric.
 - .3 Details: Not less than 1:10 metric.
 - .4 Clearly indicate changes to the location, direction, route or grade of mechanical and electrical work shown in the Contract Documents that are required or necessary arising from the coordination of the Work.
 - .5 Reproduce and distribute copies at Coordination Meeting to each concerned party in accordance with Section 01 31 19.
 - .6 Update and revise as necessary after each Coordination Meeting.
- .2 Maintain coordination documents throughout construction period, recording changes arising from modifications and adjustments; submit finalized coordination documents after completion of Project in accordance with Section 01 78 00.

Part 3 Execution

3.1 MECHANICAL AND ELECTRICAL COORDINATION

- .1 Coordinate work between Divisions 2 to 14 inclusive and Divisions 21 to 28.
- .2 Coordinate progress schedules, including dates for submittals and for delivery of products.
- .3 Conduct conferences between Subcontractors, other contractors and other concerned entities as necessary to establish and maintain coordination and schedules and to resolve matters identified by coordination activities.

- .4 Participate in Progress and Coordination Meetings; report on work requiring adjustment under coordination requirements, and any needed changes in schedules or in the work to resolve interferences between components of the Work.
- .5 Transmit minutes of coordination to all attendees and concerned individuals in accordance with Section 01 31 19.
- .6 Implementation of changes required as a result of coordination activities shall be performed as follows:
 - .1 Work Considered as No Change to Contract: Changes that **do not** materially increase or decrease the Scope-of-Work of the Contract, shall not be considered as additional work under Contract.
 - .2 Work Considered as Change to Contract: Changes that **do** materially increase or decrease the Scope-of-Work of the Contract, will be administered as a Change to the Contract in accordance with General Conditions of Contract.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE

- .1 Schedule and administer project meetings throughout the progress of the work and at the call of Departmental Representative.
- .2 Prepare agenda for meetings.
- .3 Distribute written notice of each meeting four days in advance of meeting date to Departmental Representative.
- .4 Provide physical space and make arrangements for meetings.
- .5 Preside at meetings.
- .6 Record meeting minutes. Include significant proceedings and decisions. Identify actions by parties.
- .7 Reproduce and distribute copies of minutes within three days after meetings and transmit to meeting participants and affected parties not in attendance.
- .8 Representative of Contractor, subcontractor and suppliers attending meetings will be qualified and authorized to act on behalf of party each represents.

1.2 PRECONSTRUCTION MEETING (CONSTRUCTION PARTNERING WORKSHOP)

- .1 Within 30 days after award of Contract, request a meeting of parties in contract to discuss and resolve administrative procedures and responsibilities.
- .2 Representatives of Owner, Departmental Representative, Contractor, major subcontractors, suppliers listed in bid form, field inspectors and supervisors will be in attendance.
- .3 Coordinate time and location of meeting and notify parties concerned minimum 5 days before meeting.
- .4 Agenda to include:
 - .1 Appointment of official representative of participants in the Work.
 - .2 Schedule of Work: in accordance with Construction Progress Schedules.
 - .3 Schedule of submission of shop drawings, samples, colour chips. Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
 - .4 Requirements for temporary facilities, site sign, offices, storage sheds, utilities, fences in accordance with Section 01 52 00 - Construction Facilities.
 - .5 Delivery schedule of specified equipment.
 - .6 Site security in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.
 - .7 Proposed changes, change orders, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, administrative requirements.
 - .8 Owner provided products and salvaged items as indicated on drawings.
 - .9 Record drawings in accordance with Section 01 33 00 - Submittal Procedures.

- .10 Maintenance manuals in accordance with Section 01 78 00 - Closeout Submittals.
- .11 Take-over procedures, acceptance, warranties in accordance with Section 01 78 00 - Closeout Submittals.
- .12 Monthly progress claims, administrative procedures, photographs, hold backs.
- .13 Appointment of inspection and testing agencies or firms.
- .14 Insurances, transcript of policies.

1.3 PROGRESS MEETINGS

- .1 During course of Work schedule progress meetings every two weeks.
- .2 Contractor, major subcontractors involved in Work, Departmental Representative, and Owner are to be in attendance.
- .3 Notify parties minimum 5 days prior to meetings.
- .4 Record minutes of meetings and circulate to attending parties and affected parties not in attendance within 7 days after meeting.
- .5 Agenda to include the following:
 - .1 Review, approval of minutes of previous meeting.
 - .2 Review of Work progress since previous meeting.
 - .3 Field observations, problems, conflicts.
 - .4 Problems which impede construction schedule.
 - .5 Review of off-site fabrication delivery schedules.
 - .6 Corrective measures and procedures to regain projected schedule.
 - .7 Revision to construction schedule.
 - .8 Progress schedule, during succeeding work period.
 - .9 Review submittal schedules: expedite as required.
 - .10 Maintenance of quality standards.
 - .11 Review proposed changes for affect on construction schedule and on completion date.
 - .12 Other business.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 DEFINITIONS

- .1 Activity: element of Work performed during course of Project. Activity normally has expected duration, and expected cost and expected resource requirements. Activities can be subdivided into tasks.
- .2 Bar Chart (GANTT Chart): graphic display of schedule-related information. In typical bar chart, activities or other Project elements are listed down left side of chart, dates are shown across top, and activity durations are shown as date-placed horizontal bars. Generally Bar Chart should be derived from commercially available computerized project management system.
- .3 Baseline: original approved plan (for project, work package, or activity), plus or minus approved scope changes.
- .4 Construction Work Week: Monday to Friday, inclusive, will provide five day work week and define schedule calendar working days as part of Bar (GANTT) Chart submission.
- .5 Duration: number of work periods (not including holidays or other nonworking periods) required to complete activity or other project element. Usually expressed as workdays or workweeks.
- .6 Master Plan: summary-level schedule that identifies major activities and key milestones.
- .7 Milestone: significant event in project, usually completion of major deliverable.
- .8 Project Schedule: planned dates for performing activities and the planned dates for meeting milestones. Dynamic, detailed record of tasks or activities that must be accomplished to satisfy Project objectives. Monitoring and control process involves using Project Schedule in executing and controlling activities and is used as basis for decision making throughout project life cycle.
- .9 Project Planning, Monitoring and Control System: overall system operated by Departmental Representative to enable monitoring of project work in relation to established milestones.

1.2 REQUIREMENTS

- .1 Ensure Master Plan and Detail Schedules are practical and remain within specified Contract duration.
- .2 Plan to complete Work in accordance with prescribed milestones and time frame.
- .3 Limit activity durations to maximum of approximately 10 working days, to allow for progress reporting.
- .4 Ensure that it is understood that Award of Contract or time of beginning, rate of progress, Interim Certificate and Final Certificate as defined times of completion are of essence of this contract.

1.3 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

- .2 Submit to Departmental Representative within 15 working days of Award of Contract Bar (GANTT) Chart as Master Plan for planning, monitoring and reporting of project progress.

1.4 PROJECT SCHEDULE

- .1 Develop detailed Project Schedule derived from Master Plan.
- .2 Ensure detailed Project Schedule includes as minimum milestone and activity types as follows:
 - .1 Award.
 - .2 Shop Drawings, Samples.
 - .3 Permits.
 - .4 Mobilization.
 - .5 Excavation.
 - .6 Backfill.
 - .7 Building footings.
 - .8 Slab on grade.
 - .9 Structural Steel.
 - .10 Siding and Roofing.
 - .11 Interior Architecture (Walls, Floors and Ceiling).
 - .12 Plumbing.
 - .13 Lighting.
 - .14 Electrical.
 - .15 Piping.
 - .16 Controls.
 - .17 Heating, Ventilating, and Air Conditioning.
 - .18 Fire Systems.
 - .19 Testing and Commissioning.
 - .20 Building Flushout (IAQ)
 - .21 Supplied equipment long delivery items.
 - .22 Engineer supplied equipment required dates.

1.5 PROJECT SCHEDULE REPORTING

- .1 Update Project Schedule every two weeks reflecting activity changes and completions, as well as activities in progress.
- .2 Include as part of Project Schedule, narrative report identifying Work status to date, comparing current progress to baseline, presenting current forecasts, defining problem areas, anticipated delays and impact with possible mitigation.

1.6 PROJECT MEETINGS

- .1 Discuss Project Schedule at regular site meetings, identify activities that are behind schedule and provide measures to regain slippage. Activities considered behind schedule are those with projected start or completion dates later than current approved dates shown on baseline schedule.

- .2 Weather related delays with their remedial measures will be discussed and negotiated.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE

- .1 Submit to Departmental Representative submittals listed for review. Submit promptly and in orderly sequence to not cause delay in Work. Failure to submit in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.
- .2 Do not proceed with Work affected by submittal until review is complete.
- .3 Present shop drawings, product data, samples and mock-ups in SI Metric units.
- .4 Where items or information is not produced in SI Metric units converted values are acceptable.
- .5 Review submittals prior to submission to Departmental Representative. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and co-ordinated with requirements of Work and Contract Documents. Submittals not stamped, signed, dated and identified as to specific project will be returned without being examined and considered rejected.
- .6 Notify Departmental Representative in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations.
- .7 Verify field measurements and affected adjacent Work are co-ordinated.
- .8 Contractor's responsibility for errors and omissions in submission is not relieved by Departmental Representative's review of submittals.
- .9 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Departmental Representative review.
- .10 Keep one reviewed copy of each submission on site.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.
- .2 Submit shop drawings bearing stamp and signature of qualified professional engineer registered or licensed in Province of the Work as required. The Professional Engineer shall be responsible for reviewing the method of seismic restraint and attachment to the structure with the Departmental Representative prior to installation. The Professional Engineer shall also provide field and certification of installation at Sub-contractor's cost.
- .3 Particular consideration shall be given in the design of seismic restraint anchorage to areas of the structure. Attachment of seismic restraint to the building structure must be reviewed and accepted by the Owner's Structural Departmental Representative. The Sub-Contractor shall submit seismic restraint calculations upon request for review by the Departmental Representative. Consider this article the minimum requirement. Further instruction contained in any particular specification section governs for that section of the Work.
- .4 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information

necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.

- .5 Submit shop drawings showing details of seismic restraint of architectural systems and finishes, and mechanical, plumbing and electrical equipment and associated installations, shall include the approximate weight of the item to be restrained.
- .6 Allow 10 working days for Departmental Representative's review of each submission.
- .7 Adjustments made on shop drawings by Departmental Representative are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.
- .8 Make changes in shop drawings as Departmental Representative may require, consistent with Contract Documents. When resubmitting, notify Departmental Representative in writing of revisions other than those requested.
- .9 Accompany submissions with transmittal letter containing:
 - .1 Date.
 - .2 Project title and number.
 - .3 Contractor's name and address.
 - .4 Identification and quantity of each shop drawing, product data and sample.
 - .5 Other pertinent data.
- .10 Submissions include:
 - .1 Date and revision dates.
 - .2 Project title and number.
 - .3 Name and address of:
 - .1 Subcontractor.
 - .2 Supplier.
 - .3 Manufacturer.
 - .4 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.
 - .5 Details of appropriate portions of Work as applicable:
 - .1 Fabrication.
 - .2 Layout, showing dimensions, including identified field dimensions, and clearances.
 - .3 Setting or erection details.
 - .4 Capacities.
 - .5 Performance characteristics.
 - .6 Standards.
 - .7 Operating weight.
 - .8 Wiring diagrams.
 - .9 Single line and schematic diagrams.

- .10 Relationship to adjacent work.
- .11 After Departmental Representative's review, distribute copies.
- .12 Submit electronic copy of shop drawings for each requirement requested in specification Sections and as Departmental Representative may reasonably request.
- .13 Submit electronic copies of product data sheets or brochures for requirements requested in specification Sections and as requested by Departmental Representative where shop drawings will not be prepared due to standardized manufacture of product.
- .14 Submit electronic copies of test reports for requirements requested in specification Sections and as requested by Departmental Representative.
 - .1 Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accord with specified requirements.
 - .2 Testing must have been within 3 years of date of contract award for project.
- .15 Submit electronic copies of certificates for requirements requested in specification Sections and as requested by Departmental Representative.
 - .1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements.
 - .2 Certificates must be dated after award of project contract complete with project name.
- .16 Submit electronic copies of manufacturers instructions for requirements requested in specification Sections and as requested by Departmental Representative.
 - .1 Pre-printed material describing installation of product, system or material, including special notices and Material Safety Data Sheets concerning impedances, hazards and safety precautions.
- .17 Submit electronic copies of Manufacturer's Field Reports for requirements requested in specification Sections and as requested by Departmental Representative.
 - .1 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.
- .18 Submit electronic copies of Operation and Maintenance Data for requirements requested in specification Sections and as requested by Departmental Representative.
- .19 Delete information not applicable to project.
- .20 Supplement standard information to provide details applicable to project.
- .21 If upon review by Departmental Representative, no errors or omissions are discovered or if only minor corrections are made, copies will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings,

through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.

- .22 The review of shop drawings by Public Services and Procurement Canada (PSPC) is for sole purpose of ascertaining conformance with general concept.
 - .1 This review shall not mean that PSPC approves detail design inherent in shop drawings, responsibility for which shall remain with Contractor submitting same, and such review shall not relieve Contractor of responsibility for errors or omissions in shop drawings or of responsibility for meeting requirements of construction and Contract Documents.
 - .2 Without restricting generality of foregoing, Contractor is responsible for dimensions to be confirmed and correlated at job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of Work of sub-trades.

1.3 SAMPLES

- .1 Submit for review samples in duplicate as requested in respective specification Sections. Label samples with origin and intended use.
- .2 Deliver samples prepaid to Departmental Representative's business address.
- .3 Notify Departmental Representative in writing, at time of submission of deviations in samples from requirements of Contract Documents.
- .4 Where colour, pattern or texture is criterion, submit full range of samples.
- .5 Adjustments made on samples by Departmental Representative are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.
- .6 Make changes in samples which Departmental Representative may require, consistent with Contract Documents.
- .7 Reviewed and accepted samples will become standard of workmanship and material against which installed Work will be verified.

1.4 MOCK-UPS

- .1 Erect mock-ups in accordance with 01 45 00 - Quality Control.

1.5 PHOTOGRAPHS: DIGITAL FORMAT

- .1 Progress Photographs
 - .1 Sizes: minimum 2 mega pixel image file size, jpeg image file.
 - .2 Format: CD or DVD (*.jpg).
 - .3 Viewpoints: A minimum of four (4) photographs from three (3) different viewpoints will be required.
 - .4 Number of photo sets: one (1) set per month.
 - .5 Identification: referenced to photo file with name, location, purpose, and number of project and date of exposure.
 - .6 Viewpoints: interior and exterior locations: viewpoints determined by Departmental Representative.

- .7 Frequency: at completion of excavation, foundation, framing, and services before concealment and at completion of each discrete phase of construction.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 INTENT

- .1 The intent of Delegated Design Submittals required by this section is to account for professional engineering responsibility for design, review and acceptance of components of Work forming a part of permanent Work in accordance with Building Code, and that has been assigned to a design entity other than Departmental Representative including, but not limited to, the following:
 - .1 Design requiring structural analysis of load bearing components and connections.
 - .2 Design requiring compliance with fire safety regulations.
 - .3 Design requiring compliance with life or health safety regulations.
- .2 This section provides standard forms for submittal of Letter of Commitment and Letter of Compliance required complying with requirements of Building Code and design delegated to a professional Engineer within technical specification sections.
- .3 Delegated Design Submittals are not required for components of Work requiring engineering for temporary Work (i.e.: crane hoisting, engineered lifts, false Work, shoring, concrete formwork) that would normally form a part of Contractor's scope of Work.
- .4 The requirements of this section are in general conformance with recommended Responsibilities for Engineering Services for Building Projects published by Association of Professional Engineers and Geoscientists of British Columbia (APEGBC), with regards to duties of specialty professionals appointed during construction period.
- .5 The requirements of this section do not diminish responsibilities of Departmental Representative's role as Registered Professional of Record; submittals will be used by Departmental Representative to establish that Work is substantially performed in accordance with Building Code.

1.2 RELATED SECTIONS

- .1 Section 03 30 00 Cast-In-Place Concrete: Concrete mix design
- .2 Section 05 10 00 - Structural Steel
- .3 Section 05 20 00 - Open Web Steel Joists
- .4 Section 05 30 00 - Steel Decks
- .5 Section 07 84 00 - Firestopping and Smoke seals
- .6 Section 08 44 13 – Glazed Aluminum Curtain Wall
- .7 Divisions 23 and 26 Coordinate with disciplines for items requiring delegated design submittals.

1.3 DELEGATED DESIGN

- .1 Performance and Design Criteria: Provide products and systems complying with specific performance and design criteria indicated where professional design services or certifications by a design professional are specifically required of Contractor by Contract Documents.

- .2 If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Departmental Representative.
- .3 Delegated design will be required for elements designed by a specialty professional, which may include:
 - .1 Elements normally fabricated off-site
 - .2 Elements that require specialized fabrication equipment or a proprietary fabrication process not usually available at job site (i.e.: open web steel joists, wood trusses, combination wood and metal or plywood joists, prefabricated wood or metal buildings, noise and vibration isolation devices, elevators).
 - .3 Elements requiring civil engineering, not normally a part of scope of services performed by architectural; structural; mechanical; electrical; or geotechnical disciplines of Departmental Representative.

Part 2 Products

2.1 LETTER OF COMMITMENT

- .1 Submit a signed and sealed Letter of Commitment on company letterhead addressed to Departmental Representative in accordance with format in Appendix A attached to the end of this Section prior to starting Work requiring design and seal of a professional engineer.

2.2 LETTER OF COMPLIANCE

- .1 Submit a signed and sealed Letter of Compliance on company letterhead addressed to Departmental Representative in accordance with format in Appendix B attached to the end of this Section on completion of Work requiring design and seal of a professional engineer.

Part 3 Execution

3.1 IMPLEMENTATION

- .1 Include summary of Work described in technical specification section as a part of the required Letter of Commitment.
- .2 Prepare required submittals and present to Departmental Representative within sufficient time to allow for Departmental Representative's detailed review and acceptance.

END OF SECTION

APPENDIX A

LETTER OF COMMITMENT

Submit a signed and sealed letter of commitment on company letterhead in the form as follows:

[Date]

[Departmental Representative]

[Departmental Representative's Address]

Attention: [Departmental Representative's Registered Professional of Record]

Re: Letter of Commitment for Delegated Design of [System of Component of Work]
[Name of Project]
[Project Number]
[City, Province]

As the retained registered professional engineer for design and field review of the above named component of Work and project, I hereby give assurance I am qualified to perform the following Work as required by Contract Documents:

1. [List appropriate design services for System or Component of Work];
2. Preparation of shop and erection documents;
3. Review fabrication of [structural] [fire rated] [life and health safety] components;
4. Review erection of [structural] [fire rated] [life and health safety] components.
5. [Modify list to suit System of Component of Work.]

I hereby give assurance that I will be responsible for above noted Work as described in Section [?????] – [Name of Section] of Project Manual, including requirements of addenda, change orders and change directives.

I also undertake to be responsible for field review of fabrication and erection of [structural] [fire rated] [life and health safety] components as required to ascertain substantial compliance with the Building Code and Contract Documents.

I will notify you in writing if my responsibility is terminated at any time during the course of Work covered by this Letter of Commitment.

Retained Professional Engineer

Signature

Date

(Apply seal)

APPENDIX B

LETTER OF COMPLIANCE

[Date]

[Departmental Representative]

[Departmental Representative's Address]

Attention: [Departmental Representative's Registered Professional of Record]

Re: Letter of Compliance for Delegated Design of [System of Component of Work]
[Name of Project]
[Project Number]
[City, Province]

I hereby give assurance that I have fulfilled my obligations for field review as outlined by previously submitted Letter of Commitment.

I hereby give assurance that aspects of [structural] [life and health safety] Work as defined by previously submitted Letter of Commitment substantially comply with Contract Documents and Building Code.

Retained Professional Engineer

Signature

Date

(Apply seal)

Part 1 General

1.1 REFERENCES

- .1 Canada Labour Code, Part 2, Canada Occupational Safety and Health Regulations
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .3 Province of British Columbia
 - .1 Workers Compensation Act.
 - .2 British Columbia Electrical Safety Branch Regulations
- .4 WorkSafeBC
 - .1 Occupational Health and Safety Regulation (WorkSafeBC)

1.2 SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit site-specific Health and Safety Plan: Within 7 days after date of Notice to Proceed and prior to commencement of Work. Health and Safety Plan must include:
 - .1 Results of site specific safety hazard assessment.
 - .2 Results of safety and health risk or hazard analysis for site tasks and operation found in work plan.
- .3 Submit 2 copies of Contractor's authorized representative's work site health and safety inspection reports to Departmental Representative and authority having jurisdiction, weekly.
- .4 Submit copies of reports or directions issued by Federal and Provincial health and safety inspectors.
- .5 Submit copies of incident and accident reports.
- .6 Submit WHMIS MSDS - Material Safety Data Sheets.
- .7 Departmental Representative will review Contractor's site-specific Health and Safety Plan and provide comments to Contractor within 7 days after receipt of plan. Revise plan as appropriate and resubmit plan to Departmental Representative within 7 days after receipt of comments from Departmental Representative.
- .8 Departmental Representative's review of Contractor's final Health and Safety plan should not be construed as approval and does not reduce the Contractor's overall responsibility for construction Health and Safety.
- .9 Medical Surveillance: where prescribed by legislation, regulation or safety program, submit certification of medical surveillance for site personnel prior to commencement of Work, and submit additional certifications for any new site personnel to Departmental Representative
- .10 On-site Contingency and Emergency Response Plan: address standard operating procedures to be implemented during emergency situations.

1.3 FILING OF NOTICE

- .1 File Notice of Project with Provincial authorities prior to beginning of Work.

1.4 SAFETY REQUIREMENTS

- .1 Contractor shall verify that emergency procedures including appropriate First Aid facilities and First Aid personnel are in place at the Work Site.
- .2 Contractor shall also have access to the Owner's First Aid Facilities. Conditions for use will be reviewed at the Project Start-up Meeting.
- .3 Contractor shall employ a full time, on-site Construction Safety Officer (CSO) who is responsible for the following:
 - .1 Providing new employee orientation
 - .2 Overseeing site activities
 - .3 Providing appropriate training on personal protective equipment and Workplace Hazardous Materials Information System (WHMIS)
 - .4 Conducting and documenting accident investigations as required
 - .5 Conducting daily work site inspections
 - .6 Conducting weekly site safety meetings, train new employees and verifying that [Subcontractors] [Trade Contractors], sub-subcontractors, suppliers and others working on the site are aware of safety requirements
 - .7 Requirement for a full time, on-site CSO may be waived where it can be shown that the site superintendent is certified and trained to act as the Safety Officer.
- .4 Maintain on site sufficient quantities of PPE, including but not limited to: hard hats, safety glasses, hearing protection and other items of clothing or special equipment as necessary to verify that visitors to the site, the Departmental Representative and the Owner's representative are adequately protected.
- .5 Verify that all Contractor's employees, Subcontractors, sub-subcontractors, suppliers and others working on the site, meet clothing requirements of shirts with sleeves no shorter than midway between shoulder and elbow and full length pants; muscle shirts or sleeveless shirts, cut-offs or shorts will not be allowed on the work site.

1.5 MEETINGS

- .1 Schedule and administer Health and Safety meeting with Departmental Representative and Owner prior to commencement of Work.

1.6 REGULATORY REQUIREMENTS

- .1 Do Work in accordance with Section 01 41 00 - Regulatory Requirements.

1.7 GENERAL REQUIREMENTS

- .1 Develop written site-specific Health and Safety Plan based on hazard assessment prior to beginning site Work and continue to implement, maintain, and enforce plan until final demobilization from site. Health and Safety Plan must address project specifications.

- .2 Departmental Representative may respond in writing, where deficiencies or concerns are noted and may request re-submission with correction of deficiencies or concerns.

1.8 RESPONSIBILITY

- .1 Be responsible for health and safety of persons on site, safety of property on site and for protection of persons adjacent to site and environment to extent that they may be affected by conduct of Work.
- .2 Comply with and enforce compliance by employees with safety requirements of Contract Documents, applicable federal, provincial, territorial and local statutes, regulations, and ordinances, and with site-specific Health and Safety Plan.

1.9 COMPLIANCE REQUIREMENTS

- .1 Comply with Occupational Health and Safety Act of British Columbia.

1.10 UNFORSEEN HAZARDS

- .1 When unforeseen or peculiar safety-related factor, hazard, or condition occur during performance of Work, follow procedures in place for Employee's Right to Refuse Work in accordance with Acts and Regulations of Province having jurisdiction and advise Departmental Representative verbally and in writing.

1.11 PRIME CONTRACTOR

- .1 Responsibility for Work Site Safety - This Contractor Is "Prime Contractor":
 - .1 The Contractor shall, for the purposes of the Occupational Health and Safety Act (British Columbia), and for the duration of the Work of this Contract:
 - .1 Be the "Prime Contractor" for the "Work Site", and
 - .2 Meet all requirements of the Occupational Health and Safety Act and Regulations, Workers Compensation Board legislation, the Fire Code legislation and all other applicable laws that govern work place safety.
 - .2 The Contractor shall direct all Subcontractors, sub-subcontractors, Other Contractors, employees, suppliers, workers and any other persons at the "Work Site" on safety related matters, to the extent required to fulfill its "Prime Contractor" responsibilities pursuant to the Act, regardless of:
 - .1 Whether or not any contractual relationship exists between the Contractor and any of these entities, and
 - .2 Whether or not such entities have been specifically identified in this Contract.
 - .3 Safety Certification: Safety certification is a condition of contract award; Contractor is required to maintain a valid Certificate of Recognition (COR) for the duration of the Work of this Contract.

1.12 POSTING OF DOCUMENTS

- .1 Ensure applicable items, articles, notices and orders are posted in conspicuous location on site in accordance with Acts and Regulations of Province having jurisdiction, and in consultation with Departmental Representative.

1.13 CORRECTION OF NON-COMPLIANCE

- .1 Immediately address health and safety non-compliance issues identified by authority having jurisdiction or by Departmental Representative.
- .2 Provide Departmental Representative with written report of action taken to correct non-compliance of health and safety issues identified.
- .3 Departmental Representative may stop Work if non-compliance of health and safety regulations is not corrected.

1.14 BLASTING

- .1 Blasting or other use of explosives is not permitted without prior receipt of written instruction by Departmental Representative.

1.15 POWDER ACTUATED DEVICES

- .1 Use powder actuated devices only after receipt of written permission from Departmental Representative.

1.16 WORK STOPPAGE

- .1 Give precedence to safety and health of public and site personnel and protection of environment over cost and schedule considerations for Work.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 DEFINITIONS

- .1 Environmental Pollution and Damage: presence of chemical, physical, biological elements or agents which adversely affect human health and welfare; unfavourably alter ecological balances of importance to human life; affect other species of importance to humankind; or degrade environment aesthetically, culturally and/or historically.
- .2 Environmental Protection: prevention/control of pollution and habitat or environment disruption during construction. Control of environmental pollution and damage requires consideration of land, water, and air; biological and cultural resources; and includes management of visual aesthetics; noise; solid, chemical, gaseous, and liquid waste; radiant energy and radioactive material as well as other pollutants.

1.2 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Prior to commencing construction activities or delivery of materials to site, submit Environmental Protection Plan for review and approval by Departmental Representative. Environmental Protection Plan is to present comprehensive overview of known or potential environmental issues which must be addressed during construction.
- .3 Address topics at level of detail commensurate with environmental issue and required construction tasks.
- .4 Environmental protection plan, include:
 - .1 Names of persons responsible for ensuring adherence to Environmental Protection Plan.
 - .2 Names and qualifications of persons responsible for manifesting hazardous waste to be removed from site.
 - .3 Names and qualifications of persons responsible for training site personnel.
 - .4 Descriptions of environmental protection personnel training program.
 - .5 Erosion and sediment control plan which identifies type and location of erosion and sediment controls to be provided including monitoring and reporting requirements to assure that control measures are in compliance with erosion and sediment control plan, Federal, Provincial, and Municipal laws and regulations.
 - .6 Drawings showing locations of proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials including methods to control runoff and to contain materials on site.
 - .7 Traffic control plans including measures to reduce erosion of temporary roadbeds by construction traffic, especially during wet weather. Plans include measures to minimize amount of mud transported onto paved public roads by vehicles or runoff.
 - .8 Work area plan showing proposed activity in each portion of area and identifying areas of limited use or non-use. Plan to include measures for

marking limits of use areas including methods for protection of features to be preserved within authorized work areas.

- .9 Spill Control Plan: including procedures, instructions, and reports to be used in event of unforeseen spill of regulated substance.
- .10 Non-Hazardous solid waste disposal plan identifying methods and locations for solid waste disposal including clearing debris.
- .11 Air pollution control plan detailing provisions to assure that dust, debris, materials, and trash, do not become air borne and travel off project site.
- .12 Contaminant prevention plan that: identifies potentially hazardous substances to be used on job site; identifies intended actions to prevent introduction of such materials into air, water, or ground; and details provisions for compliance with Federal, Provincial, and Municipal laws and regulations for storage and handling of these materials.
- .13 Waste water management plan that identifies methods and procedures for management and/or discharge of waste waters which are directly derived from construction activities, such as concrete curing water, clean-up water, dewatering of ground water, disinfection water, hydrostatic test water, and water used in flushing of lines.

1.3 FIRES

- .1 Fires and burning of rubbish on site not permitted.

1.4 DISPOSAL OF WASTES

- .1 Strictly adhere to requirements of Section 01 74 21 Waste Management and Disposal. Do not bury rubbish and waste materials on site unless approved by Departmental Representative.
- .2 Do not dispose of waste or volatile materials, such as mineral spirits, oil or paint thinner into waterways, storm or sanitary sewers.

1.5 DRAINAGE

- .1 Provide erosion and sediment control plan that identifies type and locations of erosion and sediment controls to be provided. Plan: include monitoring and reporting requirements to assure that control measure are in compliance with erosion and sediment control plan, Federal, Provincial, and Municipal laws and regulations.
- .2 Storm Water Pollution Prevention Plan (SWPPP) to be substituted for erosion and sedimentations control plan.
- .3 Provide temporary drainage and pumping as necessary to keep excavations and site free from water.
- .4 Do not pump water containing suspended materials into waterways or drainage systems. Migration to water retention pond is allowed.
- .5 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with local authority requirements.

1.6 SITE CLEARING AND PLANT PROTECTION

- .1 Protect trees and plants on site and adjacent properties where indicated on Drawings and in Specifications.

- .2 Wrap in burlap, trees and shrubs adjacent to construction work, storage areas and trucking lanes, and encase with protective wood framework from grade level to height of 2 m.
- .3 Protect roots of designated trees to dripline during excavation and site grading to prevent disturbance or damage. Avoid unnecessary traffic, dumping and storage of materials over root zones.
- .4 Minimize stripping of topsoil and vegetation.
- .5 Restrict tree removal to areas indicated or designated by Departmental Representative.

1.7 WORK ADJACENT TO WATERWAYS

- .1 Do not operate construction equipment in waterways.
- .2 Do not use waterway beds for borrow material.
- .3 Do not dump excavated fill, waste material or debris in waterways.
- .4 Design and construct temporary crossings to minimize erosion to waterways.
- .5 Do not skid logs or construction materials across waterways.
- .6 Avoid indicated spawning beds when constructing temporary crossings of waterways.
- .7 Do not blast under water or within 100 m of indicated spawning beds.

1.8 NATIONAL PARKS ACT

- .1 Perform work in accordance with the ordinances and laws set out in the National Parks Act and Regulations.
- .2 Refer to the requirements stated in the Basic Impact Assessment (BIA) dated August 29, 2018 in Appendix A.

1.9 HISTORICAL/ARCHAEOLOGICAL CONTROL

- .1 Provide historical, archaeological, cultural resources, biological resources, and wetlands plan that defines procedures for identifying and protecting historical, archaeological, cultural resources, biological resources and wetlands known to be on project site: and identifies procedures to be followed if historical archaeological, cultural resources, biological resources and wetlands not previously known to be onsite or in area are discovered during construction.
- .2 Plan: include methods to assure protection of known or discovered resources and identify lines of communication between Contractor personnel and Departmental Representative.
- .3 In the event that historical, archaeological, cultural resources, biological resources or wetlands are accidentally discovered on-site the Contractor is to immediately cease work and notify the Departmental Representative.

1.10 POLLUTION CONTROL

- .1 Maintain temporary erosion and pollution control features installed under this contract.

- .2 Control emissions from equipment and plant to local authorities' emission requirements.
- .3 Prevent sandblasting and other extraneous materials from contaminating air and waterways beyond application area, by providing temporary enclosures.
- .4 Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control for temporary roads.

1.11 NOTIFICATION

- .1 Departmental Representative will notify Contractor in writing of observed noncompliance with Federal, Provincial or Municipal environmental laws or regulations, permits, and other elements of Contractor's Environmental Protection plan.
- .2 Contractor: after receipt of such notice, inform Departmental Representative of proposed corrective action and take such action for approval by Departmental Representative.
- .3 Departmental Representative will issue stop order of work until satisfactory corrective action has been taken.
- .4 No time extensions granted or equitable adjustments allowed to Contractor for such suspensions.

1.12 ADDITIONAL MITIGATION MEASURES

.1 Air Quality:

- .1 To reduce noise and air pollution, construction equipment will be turned off when not in use. Daily start and end times for construction works shall be determined in consultation with the Departmental Representative.
- .2 Dust/particulate suppression techniques shall be implemented as required, or as deemed necessary by the Project Manager and Construction Site Supervisor, to ensure applicable air quality guidelines are met.

.2 Soil and Landforms:

- .1 It is the responsibility of the contractor to secure the site throughout construction and ensure public safety is always maintained.
- .2 It is the responsibility of the contractor to develop and implement a sediment and erosion control plan.
- .3 As a remedial excavation is being conducted prior to this project commencing, any existing subsurface contamination will most likely be removed. However, should suspected contaminated soils be encountered during this project, the Contractor is to follow the mitigations outlined in MRG Contaminated Soils Construction Guide (2012) which will be provided to contractor upon contract award.
- .4 The project area is located within a registered federal contaminated site and there are several groundwater monitoring wells within the Site. It is the contractor's responsibility to document and mark the location of existing wells prior to physical works to ensure these are protected during all construction activities. All excavation works should maintain a minimum 1m buffer from all monitoring wells, deviation from this must be discussed with PCA departmental representative. Any changes in grade to the existing ground will impact monitoring wells, adjustments to well elevations shall follow the MRG Groundwater Well Adjustment, Repair and Decommissioning BMP DRAFT (2018).

.3 Fauna:

- .1 The Contractor shall be aware of sensitive wildlife windows (e.g. bird breeding, bat roosting, etc.) within GNP. The Nesting Bird Window is April 1st to August 31st and no disturbance of nesting migratory birds is to take place within this period.
- .2 Works shall be scheduled outside sensitive wildlife periods as much as possible (bat roosting, etc.).
- .3 All observations of or encounters with wildlife and species at risk within GNP must be immediately reported to Parks Canada Wildlife personnel via Jasper Dispatch. Species groups of particular interest include: caribou, bears, mountain goats, amphibians, birds (especially attempting to build nests), bats, and fish. Observations of road kills should also be reported.
- .4 If amphibians are observed in numbers that may indicate a migration is taking place, work must be halted to avoid trampling and Parks Canada Resource Conservation staff must be notified. A plan for amphibian

exclusion fencing and/or salvage will be initiated as soon as possible to minimize work disruptions.

- .5 If large mammals are present, work shall be halted until the wildlife have passed through the area and/or have been hazed out of the area by Parks Canada Resource Conservation staff.
- .6 All efforts to prevent wildlife from obtaining food, garbage or other domestic wastes shall be made by the Contractor and contract staff while undertaking work in National Parks. Such wildlife attractants shall not be stored at the work site overnight. Lunches, coolers and food products, including waste food products, shall be securely stored away from access by animals. Daily removal from the park and off-site disposal of food scraps, food wrappers, drink containers, domestic waste, and other potential wildlife attractants is mandatory. Existing Parks Canada waste receptacles shall not be used for disposal of such wastes without prior arrangement with the Project Manager. Incidents involving wildlife accessing garbage or attractants should be reported immediately to Jasper Dispatch, Impact Assessment Coordinator or ESO.
- .7 Feeding, harassment or destruction of any wildlife is strictly prohibited. Wildlife encountered at or near Project locations will be allowed to passively disperse without undue harassment. Nuisance wildlife will be immediately reported to the Parks Canada personnel via Jasper Dispatch.
- .8 Construction traffic must yield right-of-way to wildlife.
- .9 Temporary lighting installed on site will be directed downwards to minimize nighttime disturbance and light pollution.

.4 Flora:

- .1 All Contractor's equipment will be stored with drip trays and either on roads or on hardened surfaces in order to avoid: trampling roadside vegetation, compaction of soils and staging in areas infested with IAP.
- .2 Should effects to vegetation occur as a result of the proposed Project activities, efforts will be made by the Contractor to re-vegetate and rehabilitate the disturbed area with vegetation native to the area according to Mount Revelstoke and Glacier (MRG) planting criteria in collaboration with the Departmental Representative.
- .3 Prior to accessing the site, all construction equipment will be pressure washed or steam cleaned to prevent the transport of IAP to disturbed soil that may be easily invaded. In particular, tire treads, wheel wells and bumper areas shall be clear of dirt, seeds and plant debris from former work sites.
- .4 If IAP species are identified on-site and are suspected to have colonized due to construction activities, Parks Canada staff should be notified immediately to determine appropriate measures of treatment.
- .5 Any re-vegetating or hydro-seeding to occur onsite must use the MRG Approved Seed-mix and Hydraulic Erosion Control Product. Contractors are required to provide the Impact Assessment Coordinator Seed Certificates for verification prior any use/application of a seed-mix.
- .6 If landscaping or other planting (in addition to MRG specific seed-mix) is conducted, the Project Manager must present a list of intended plant species to be used to the MRG Vegetation Ecologist for verification prior to conducting the planting.

- .7 Any tree or brush removal will follow the MRG Vegetation Removal BMP (2015).

.5 Cultural Resources

- .1 Specific mitigations related to cultural resources have been identified in Letter of Clearance: Rogers Pass West 2018 (Permit GLA-2018-28582) which will be provided to the successful bidder upon contract award, specifically that monitoring by a professional archaeologist must occur during soil disturbance activities in native ground within the vicinity of the former service station (Appendix 4, areas shaded in yellow). Areas where monitoring is required have been defined by test pit results and are specifically targeted at intact refuse midden deposits associated with historic CPR railway workers houses, and structural remains of the Rogers Pass No. 3 stations house, water tank and tool sheds.
- .2 The MRG Accidental Finds Protocol will be in effect for the duration of the Project.
- .3 Any additional scope and/or Project footprint changes should be reviewed by Parks Canada CRM and Archaeology as they may affect Project requirements.
- .4 Site visits by members of the PCA Terrestrial Archaeology team may be required during the pre-impact assessments or monitoring phase to evaluate progress, inspect finds and provide advice.
- .5 The actual Project footprint will be submitted to Parks Canada CRM and Archaeology prior to project commencement.
- .6 Report any unanticipated impacts to the cultural resources of the NHS or the national park to Archaeology or national CRM, as indicated.

.6 Visitor Experience

- .1 A Traffic Management Plan will be developed for review and approval by the Parks Canada Project Manager, and implemented by the Contractor.
- .2 Temporary signs, supplied by Parks Canada, will be placed strategically in locations around the Project site, in the Rogers Pass Discovery Centre and at other key visitor facilities in GNP, to provide visitors with information regarding the construction activities, temporary closures, work periods and timelines.
- .3 It is the responsibility of the Contractor to secure the Project site throughout construction and ensure public safety is always maintained.
- .4 To reduce noise and air pollution, construction equipment will be turned off when not in use. Daily start and end times for construction works shall be determined in consultation with the Departmental Representative.

1.13 PROJECT SPECIFIC MITIGATION MEASURES

- .1 It is expected that all staff and contractors will understand and comply with all Canada National Parks Act and regulations within the Park. All staff employed at the construction site will be required to attend an environmental briefing with the Parks Canada Environmental Surveillance Officer (ESO) regarding their individual and collective responsibilities to ensure avoidable adverse environmental impact does not arise from their activities and personal choices. This information will be available on site and provided to any new workers and/or

- subcontractors such that subsequent environmental briefings can be presented by arrangement with the ESO through the Departmental Representative.
- .2 It is the responsibility of the Project Manager to ensure that all Project works are conducted in accordance with all applicable regulations and approvals including, but not limited to, the Fisheries Act, Species at Risk Act, Migratory Birds Convention Act and Canada National Parks Act.
 - .3 It is the responsibility of the contractor to obtain all necessary permits prior to the commencement of Project activities.
 - .4 An ESO will be assigned by PCA to provide periodic and unscheduled site visits to ensure that Project operations are conducted in accordance with all identified environmental protection measures (including, but not limited to those within this document), applicable legislation and construction Best Management Practices. The ESO maintains the right to halt any work that does not comply with all Project Approvals, Permits or Authorizations. The contractor is responsible for undertaking environmental monitoring and follow up reporting of rehabilitation works such that criteria in PCA Approvals and the EPP are being adhered to.
 - .5 It is the responsibility of the Project Manager to provide Parks Canada staff with advance notifications of Project activities.
 - .6 All site workers are required to wear appropriate Personal Protective Equipment (PPE) and be trained to standards that comply with Worksafe BC.
 - .7 All vehicles shall be parked at least 10 m from any watercourse and on hardened surfaces. Heavy equipment/machinery will also be fitted with appropriate drip trays.
 - .8 Firearms and pets are prohibited on site.
 - .9 Fishing is prohibited on site and anywhere in GNP without a valid permit.
 - .10 Park campgrounds will not be used for staff accommodation.
 - .11 The Contractor assumes any risk to public safety as a result of Project activities.
 - .12 In addition to what is outlined in this assessment, all other applicable Best Management Practices should be followed if they apply, this may include but is not limited to:
 - .1 PCA National BMP – Campground and Day Use Areas (August 2016)
 - .2 PCA National BMP – Common Activities (March 2017)
 - .3 MRG Accidental Finds Protocol (2017)
 - .4 MRG Vegetation Removal BMP (2015)
 - .5 MRG Installation of Pre-fabricated Structures (2015)
 - .6 MRG Contaminated Soils Construction Guide (2012)
 - .7 MRG Groundwater Well Adjustment, Repair and Decommissioning BMP DRAFT

Part 2 Products

2.11 NOT USED

Part 3 Execution

3.11 NOT USED

END OF SECTION

Control emissions from equipment and plant to local authorities' emission requirements.

Prevent sandblasting and other extraneous materials from contaminating air and waterways beyond application area, by providing temporary enclosures.

Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control for temporary roads.

NOTIFICATION

Departmental Representative will notify Contractor in writing of observed noncompliance with Federal, Provincial or Municipal environmental laws or regulations, permits, and other elements of Contractor's Environmental Protection plan.

Contractor: after receipt of such notice, inform Departmental Representative of proposed corrective action and take such action for approval by Departmental Representative.

Departmental Representative will issue stop order of work until satisfactory corrective action has been taken.

No time extensions granted or equitable adjustments allowed to Contractor for such suspensions.

Products

NOT USED

Execution

NOT USED

END OF SECTION

Part 2

2.1

Part 3

3.1

Part 1 General

1.1 REFERENCES AND CODES

- .1 Perform Work in accordance with National Building Code (2015), and NECB 2011 including amendments up to tender closing date and other codes of provincial or local application. In case of conflict or discrepancy, more stringent requirements apply.
- .2 Meet or exceed requirements of:
 - .1 Contract documents.
 - .2 Specified standards, codes and referenced documents.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 Summary

- A. All references to codes, standards and standard specifications referred to in these Specifications or used on drawings shall mean and intend to be the currently adopted edition, amendment and revision of such reference standards in effect at the time of Bid closing.
- B. In the event that the most current version of a code, standard or standard specification differs from the version indicated in these Specifications:
 - 1. Report the discrepancy to the Construction Manager and Departmental Representative immediately.
 - 2. The most current standard at time of Tender will be used to establish the quality of the work or material being referenced.
- C. Referenced standards and code requirements shall be considered minimum requirements only. The Specifications may indicate additional requirements in excess of those established by referenced codes and standards.
- D. Applicable portions of Standards used that are not in conflict with the Contract Documents are hereby made a part of the Specifications.
- E. Modifications or exceptions to Standards shall be considered as amendments, and unmodified portions shall remain in full effect.
- F. In cases of discrepancies between the Specifications and Standards, the requirements of the Specification shall govern.
- G. In cases of discrepancies between Codes and the Specifications, the Code requirements shall govern.
- H. Where references to Codes or Standards are used in these Specifications, the Subcontractors must familiarize themselves with the applicable portions and shall be governed by the requirements affecting the Project.
- I. The Subcontractor shall provide an affidavit, when requested by the Construction Manager and/or the Departmental Representative, from manufacturers certifying that materials or products delivered to the project meet the requirements specified. Such certifications, however, shall not relieve the Subcontractors from the responsibility of complying with any added requirements specified in the Contract Documents.

1.2 Standards Equivalency

- A. Documents were prepared in the United States of America and in Canada. Reference standards used to establish performance requirements listed in the technical specifications for Work of the Project were prepared using mixed reference standards from the United States and Canada, whereby Canadian will take precedence.

1. National Standards of Canada: Standards Referenced within the National Building Code are National Standards of Canada as accepted by the Standards Council of Canada and enforced by the Authority Having Jurisdiction.
 2. Technical Specification Content: The Departmental Representative has modified and referenced the correct listings of Referenced Standards within the technical specifications where they reference National Standards of Canada applicable to work governed by the National Building Code.
 3. Names of Standards Organizations: Bilateral standards published in the United States of America and containing the word “American” when referenced as National Standards of Canada have the same weight as a standard containing the word “Canadian”:
 - a. Country of testing origin does not prejudice the acceptability of the listed standards.
 - b. All standards listed in the technical specifications are listed alphabetically, with no preference for country of origin.
- B. Materials, assemblies or systems that are tested in the United States using reference standards acceptable to Standards Council of Canada, with no equivalent Canadian reference standards are acceptable for use in Work of the Project using manufacturers’ standard product data and testing meeting the listed reference standards.
- C. Provide materials, assemblies or systems meeting Canadian reference standards acceptable to Standards Council of Canada where manufacturers conduct testing concurrently with reference standards published in the United States; and that are different than Canadian reference standards.
- D. Submit product data indicating Canadian equivalent performance to specified United States reference standards as follows:
1. Submit product data listing CSA, CGSB, ULC or similar reference standard indicating testing acceptable to the Authority Having Jurisdiction.
 2. Use same material, assembly or system as would be required for a tested material, assembly or system specified for the project; substitutions will not be permitted unless evidence of equivalency is confirmed.
 3. Submit manufacturer's product data for materials and prefabricated devices, providing descriptions are sufficient for identification at job site; include manufacturer's printed instructions for installation.

1.3 Standards Organizations

- A. The following list of standards organizations indicate the most common standards that may be referenced within the technical specifications:
1. ANSI - American National Standards Institute
 2. ASTM - American Society for Testing and Materials
 3. CGA - Canadian Gas Association
 4. CGSB - Canadian General Standards Board
 5. CSA - Canadian Standards Association
 6. CAN1 - National Standard of Canada (published by CGA)
 7. CAN2 - National Standard of Canada (published by CGSB)
 8. CAN3 - National Standard of Canada (published by CSA)

9. CAN4 - National Standard of Canada (published by ULC)
 10. ULC - Underwriters Laboratories of Canada
 11. UL or ULI - Underwriters Laboratories Inc.
 12. NFPA - National Fire Protection Agency
 13. WHI - Warnock Hersey | Intertek Testing Services
- B. The following limitations on marks issued by standards organizations will apply to the standards issued by the organizations listed in above:
1. Underwriters Laboratories Inc.: Only systems designated by “cUL” or “cUL_{US}” will be acceptable for use on this project. Systems indicating “UL” or “UL_{US}” will only be considered where local authorities having jurisdiction have reviewed and accepted the systems in writing.
 2. Warnock Hersey Intertek: Only materials designated by “cWHI” or “cWHI_{US}” will be acceptable for use on this project. Materials bearing a “WH”, “WHI” or “WHI_{US}” mark will only be considered where local authorities having jurisdiction have reviewed and accepted the materials in writing.
 3. Subcontractor will be responsible for obtaining written acceptance of materials and submitting them to the Departmental Representative prior to installation.

1.4 ABBREVIATIONS

- A. Additional Technical Societies, Associations, or Standards may be referenced in these Specifications in addition to the following abbreviations:

Name of Association	Abbreviation
Acoustical Materials Association	AMA
Air Movement & Control Association	AMCA
American Concrete Institute	ACI
American Iron & Steel Institute	AISI
American Society of Heating, Refrigerating and Airconditioning Engineers	ASHRAE
American Society of Mechanical Engineers	ASME
American Standards Association	ASA
American Wood Preservers' Association	AWPA
Architectural Woodwork Manufacturers Association of Canada	AWMAC
Canadian Institute of Steel Construction	CISC
Ceilings and Interior Systems Construction Association	CISCA
Canadian Sheet Steel Building Institute	CSSBI
Canadian Welding Bureau	CWB
Construction Specifications Canada	CSC
Factory Mutual	FM
Heating, Refrigerating and Airconditioning Institute of Canada	HRAI
Hydronics Institute	HI
Industrial Fabric Association International	IFAI

Name of Association	Abbreviation
Insulated Glass Manufacturers Association of Canada	IGMAC
Master Painters Institute	MPI
National Association of Architectural Metal Manufacturers	NAAMM
National Building Code	NBC
National Lumber Grades Authority	NLGA
Northwest Wall and Ceiling Bureau	NWCB
Terrazzo, Tile & Marble Association of Canada	TTMAC
The Society for Protective Coatings	SSPC

Part 2 Products

2.1 Not used

Part 3 Execution

3.1 Not Used

END OF SECTION

Part 1 General

1.1 INSPECTION/FIELD REVIEW

- .1 Allow Departmental Representative access to Work. If part of Work is in preparation at locations other than Place of Work, allow access to such Work whenever it is in progress.
- .2 Give timely notice requesting inspection if Work is designated for special tests, inspections or approvals by Departmental Representative instructions, or law of Place of Work.
- .3 If Contractor covers or permits to be covered Work that has been designated for special tests, inspections or approvals before such is made, uncover such Work, have inspections or tests satisfactorily completed and make good such Work.
- .4 Departmental Representative will order part of Work to be examined if Work is suspected to be not in accordance with Contract Documents. If, upon examination such work is found not in accordance with Contract Documents, correct such Work and pay cost of examination and correction. If such Work is found in accordance with Contract Documents, Owner shall pay cost of examination and replacement.

1.2 INDEPENDENT INSPECTION AGENCIES

- .1 Independent Inspection/Testing Agencies will be engaged by Departmental Representative for purpose of inspecting and/or testing portions of Work. Cost of such services will be borne by Owner.
- .2 Provide equipment required for executing inspection and testing by appointed agencies.
- .3 Employment of inspection/testing agencies does not relax responsibility to perform Work in accordance with Contract Documents.
- .4 If defects are revealed during inspection or testing, appointed agency will request additional inspection or testing to ascertain full degree of defect. Correct defect and irregularities as advised by Departmental Representative at no cost to Owner. Pay costs for retesting and reinspection.

1.3 ACCESS TO WORK

- .1 Allow inspection/testing agencies access to Work, off site manufacturing and fabrication plants.
- .2 Co-operate to provide reasonable facilities for such access.

1.4 PROCEDURES

- .1 Notify appropriate agency in advance of requirement for tests, in order that attendance arrangements can be made.
- .2 Submit samples or materials required for testing, as specifically requested in specifications. Submit with reasonable promptness and in orderly sequence to not cause delays in Work.
- .3 Provide labour and facilities to obtain and handle samples and materials on site. Provide sufficient space to store and cure test samples.

1.5 REJECTED WORK

- .1 Remove defective Work, whether result of poor workmanship, use of defective products or damage and whether incorporated in Work or not, which has been rejected by Departmental Representative as failing to conform to Contract Documents. Replace or re-execute in accordance with Contract Documents.
- .2 Make good other Contractor's work damaged by such removals or replacements promptly.
- .3 If in opinion of Departmental Representative it is not expedient to correct defective Work or Work not performed in accordance with Contract Documents, Owner will deduct from Contract Price difference in value between Work performed and that called for by Contract Documents, amount of which will be determined by Departmental Representative.

1.6 REPORTS

- .1 Submit electronic copies of inspection and test reports to Departmental Representative.
- .2 Provide copies to subcontractor of work being inspected or tested and manufacturer or fabricator of material being inspected or tested.

1.7 TESTS AND MIX DESIGNS

- .1 Furnish test results and mix designs as requested.
- .2 Cost of tests and mix designs beyond those called for in Contract Documents or beyond those required by law of Place of Work will be appraised by Departmental Representative and may be authorized as recoverable.

1.8 MOCK-UPS

- .1 Prepare mock-ups for Work specifically requested in specifications. Include for Work of Sections required to provide mock-ups.
- .2 Construct in locations acceptable to Departmental Representative or as specified in specific Section.
- .3 Prepare mock-ups for Departmental Representative's review with reasonable promptness and in orderly sequence, to not cause delays in Work.
- .4 Failure to prepare mock-ups in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.
- .5 If requested, Departmental Representative will assist in preparing schedule fixing dates for preparation.
- .6 Remove mock-up at conclusion of Work or when acceptable to Departmental Representative.
- .7 Mock-ups may remain as part of Work.
- .8 Specification section identifies whether mock-up may remain as part of Work or if it is to be removed and when.

1.9 MILL TESTS

- .1 Submit mill test certificates as requested or required of specification Sections.

1.10 EQUIPMENT AND SYSTEMS

- .1 Submit adjustment and balancing reports for mechanical, electrical and building equipment systems.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 U.S. Environmental Protection Agency (EPA / Office of Water
.1 2003 U.S. EPA Construction General Permit.

1.2 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

1.3 INSTALLATION AND REMOVAL

- .1 Provide temporary utilities controls in order to execute work expeditiously.
- .2 Remove from site all such work after use.

1.4 DEWATERING

- .1 Provide temporary drainage and pumping facilities to keep excavations and site free from standing water.

1.5 WATER SUPPLY

- .1 Provide continuous supply of potable water for construction use.

1.6 TEMPORARY HEATING AND VENTILATION

- .1 Refer to Section 01 47 18 Indoor Air Quality and follow requirements for implementation of Indoor Air Quality Management Plan.
- .2 Provide temporary heating required during construction period, including attendance, maintenance and fuel.
- .3 Construction heaters used inside building must be vented to outside or be non-flameless type. Solid fuel salamanders are not permitted.
- .4 Provide temporary heat and ventilation in enclosed areas as required to:
 - .1 Facilitate progress of Work.
 - .2 Protect Work and products against dampness and cold.
 - .3 Prevent moisture condensation on surfaces.
 - .4 Provide ambient temperatures and humidity levels for storage, installation and curing of materials.
 - .5 Provide adequate ventilation to meet health regulations for safe working environment.
- .5 Maintain temperatures of minimum 10 degrees C in areas where construction is in progress.
- .6 Ventilating:
 - .1 Meet requirements of Section 01 47 18 Indoor Air Quality.

- .2 Prevent accumulations of dust, fumes, mists, vapours or gases in areas occupied during construction.
- .3 Provide local exhaust ventilation to prevent harmful accumulation of hazardous substances into atmosphere of occupied areas.
- .4 Dispose of exhaust materials in manner that will not result in harmful exposure to persons.
- .5 Ventilate storage spaces containing hazardous or volatile materials.
- .6 Ventilate temporary sanitary facilities.
- .7 Continue operation of ventilation and exhaust system for time after cessation of work process to assure removal of harmful contaminants.
- .7 Permanent heating system of building, to be used when available. Be responsible for damage to heating system if use is permitted.
- .8 On completion of Work for which permanent heating system is used, replace filters, replace bearings, and clean. Thoroughly clean permanent equipment used during construction.
- .9 Ensure Date of Substantial Performance and Warranties for heating system do not commence until entire system is in as near original condition as possible and is certified by Departmental Representative.
- .10 Pay costs for maintaining temporary heat, when using permanent heating system
- .11 Maintain strict supervision of operation of temporary heating and ventilating equipment to:
 - .1 Meet requirements of Section 01 47 18 Indoor Air Quality.
 - .2 Conform with applicable codes and standards.
 - .3 Enforce safe practices.
 - .4 Prevent abuse of services.
 - .5 Prevent damage to finishes.
 - .6 Vent direct-fired combustion units to outside.
- .12 Be responsible for damage to Work due to failure in providing adequate heat and protection during construction.

1.7 TEMPORARY POWER AND LIGHT

- .1 Provide temporary power and temporary lighting and operating of power tools, as required.
- .2 Work includes installation, maintenance and removal of related temporary utilities.
- .3 Temporary power for electric cranes and other equipment requiring in excess of above is responsibility of Contractor.
- .4 Provide and maintain temporary lighting throughout project. Ensure level of illumination on all floors and stairs is not less than 162 lx.
- .5 Electrical power and lighting systems installed under this Contract may be used for construction requirements only with prior approval of Departmental Representative provided that guarantees are not affected. Make good damage to electrical system caused by use under this Contract. Replace lamps which have been used for more than 3 months.

1.8 TEMPORARY COMMUNICATION FACILITIES

- .1 Provide temporary telephone and data hook up, lines and equipment necessary for own use and use of Departmental Representative.

1.9 FIRE PROTECTION

- .1 Provide and maintain temporary fire protection equipment during performance of Work required by insurance companies having jurisdiction and governing codes, regulations and bylaws.
- .2 Burning rubbish and construction waste materials is not permitted on site.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 1.189-00, Exterior Alkyd Primer for Wood.
 - .2 CGSB 1.59-97, Alkyd Exterior Gloss Enamel.
- .2 Canadian Standards Association (CSA International)
 - .1 CSA-A23.1-14/A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete, Includes Updates through No. 3 August 2006.
 - .2 CSA-0121-08 (R2013), Douglas Fir Plywood.
 - .3 CAN/CSA-S269.2-M87(R2003), Access Scaffolding for Construction Purposes.
- .3 U.S. Environmental Protection Agency (EPA) / Office of Water
 - .1 2003 U.S. EPA Construction General Permit.

1.2 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

1.3 INSTALLATION AND REMOVAL

- .1 Prepare site plan indicating proposed location and dimensions of area to be fenced and used by Contractor, number of trailers to be used, avenues of ingress/egress to fenced area and details of fence installation.
- .2 Identify areas which have to be gravelled to prevent tracking of mud.
- .3 Indicate use of supplemental or other staging area.
- .4 Provide construction facilities in order to execute work expeditiously.
- .5 Remove from site all such work after use.

1.4 SCAFFOLDING

- .1 Scaffolding in accordance with CAN/CSA-S269.2.
- .2 Provide and maintain scaffolding, ramps, ladders, swing staging, platforms and temporary stairs.

1.5 HOISTING

- .1 Provide, operate and maintain hoists cranes required for moving of workers, materials and equipment. Make financial arrangements with Subcontractors for their use of hoists.
- .2 Hoists cranes to be operated by qualified operator.

1.6 SITE STORAGE/LOADING

- .1 Confine work and operations of employees by Contract Documents. Do not unreasonably encumber premises with products.

- .2 Do not load or permit to load any part of Work with weight or force that will endanger Work.

1.7 CONSTRUCTION PARKING

- .1 Parking will be permitted on site provided it does not disrupt performance of Work.
- .2 Provide and maintain adequate access to project site.

1.8 SECURITY

- .1 Secure site and contents of site after working hours and during holidays.
- .2 Provide fencing and additional security as deemed necessary.

1.9 OFFICES

- .1 Provide office heated to 22 degrees C, lighted 750 lx and ventilated, of sufficient size to accommodate site meetings and furnished with drawing laydown table.
- .2 Provide marked and fully stocked first-aid case in a readily available location.
- .3 Subcontractors to provide their own offices as necessary. Direct location of these offices.

1.10 EQUIPMENT, TOOL AND MATERIALS STORAGE

- .1 Provide and maintain, in clean and orderly condition, lockable weatherproof sheds for storage of tools, equipment and materials.
- .2 Locate materials not required to be stored in weatherproof sheds on site in manner to cause least interference with work activities.

1.11 SANITARY FACILITIES

- .1 Provide sanitary facilities for work force in accordance with governing regulations and ordinances.
- .2 Post notices and take precautions as required by local health authorities. Keep area and premises in sanitary condition.
- .3 When permanent water and drain connections are completed, provide temporary water closets and urinals complete with temporary enclosures, inside building. Permanent facilities may be used on approval of Departmental Representative.

1.12 CONSTRUCTION SIGNAGE

- .1 No signs or advertisements, other than warning signs, are permitted on site, unless necessary for contract general conditions and requirements. All other signs must be authorized by Departmental Representative.

1.13 **PROTECTION AND MAINTENANCE OF TRAFFIC**

- .1 Provide access and temporary relocated roads as necessary to maintain traffic.
- .2 Maintain and protect traffic on affected roads during construction period except as otherwise specifically directed by Departmental Representative.
- .3 Provide measures for protection and diversion of traffic, including provision of watch-persons and flag-persons, erection of barricades, placing of lights around and in front of equipment and work, and erection and maintenance of adequate warning, danger, and direction signs
- .4 Protect travelling public from damage to person and property.
- .5 Contractor's traffic on roads selected for hauling material to and from site to interfere as little as possible with public traffic.
- .6 Verify adequacy of existing roads and allowable load limit on these roads.
Contractor: responsible for repair of damage to roads caused by construction operations.
- .7 Construct access and haul roads necessary.
- .8 Haul roads: constructed with suitable grades and widths; sharp curves, blind corners, and dangerous cross traffic shall be avoided.
- .9 Provide necessary lighting, signs, barricades, and distinctive markings for safe movement of traffic.
- .10 Dust control: adequate to ensure safe operation at all times.
- .11 Location, grade, width, and alignment of construction and hauling roads: subject to approval by Departmental Representative.
- .12 Lighting: to assure full and clear visibility for full width of haul road and work areas during night work operations.
- .13 Provide snow removal during period of Work.
- .14 Remove, upon completion of work, haul roads designated by Departmental Representative.

1.14 **CLEAN-UP**

- .1 Remove construction debris, waste materials, packaging material from work site daily.
- .2 Clean dirt or mud tracked onto paved or surfaced roadways.
- .3 Store materials resulting from demolition activities that are salvageable.
- .4 Stack stored new or salvaged material not in construction facilities.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to sediment and erosion control plan, specific to site, that complies with 2003 U.S. EPA Construction General Permit or requirements of authorities having jurisdiction, whichever is more stringent.
- .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian General Standards Board (CGSB)
 - .1 CGSB 1.59-97, Alkyd Exterior Gloss Enamel.
 - .2 CAN/CGSB 1.189-00, Exterior Alkyd Primer for Wood.
- .2 Canadian Standards Association (CSA International)
 - .1 CSA-O121-08 (R2013), Douglas Fir Plywood.

1.2 INSTALLATION AND REMOVAL

- .1 Provide temporary controls in order to execute Work expeditiously.
- .2 Remove from site all such work after use.

1.3 HOARDING

- .1 Erect temporary site enclosure using purpose made, prefabricated interlocking metal fence panels 2.1 m high.
- .2 Provide one lockable truck entrance gate and at least one pedestrian door as directed and conforming to applicable traffic restrictions on adjacent streets. Equip gates with locks and keys.
- .3 Erect and maintain pedestrian walkways including roof and side covers, complete with signs and electrical lighting as required by law.
- .4 Provide barriers around trees and plants designated to remain. Protect from damage by equipment and construction procedures.

1.4 GUARD RAILS AND BARRICADES

- .1 Provide secure, rigid guard rails and barricades around deep excavations, open shafts, open stair wells, open edges of floors and roofs.
- .2 Provide as required by governing authorities.

1.5 WEATHER ENCLOSURES

- .1 Provide weather tight closures to unfinished door and window openings, tops of shafts and other openings in floors and roofs.
- .2 Close off floor areas where walls are not finished; seal off other openings; enclose building interior work for temporary heat.
- .3 Design enclosures to withstand wind pressure and snow loading.

1.6 DUST TIGHT SCREENS

- .1 Provide dust tight screens or insulated partitions to localize dust generating activities, and for protection of workers, finished areas of Work and public.
- .2 Maintain and relocate protection until such work is complete.

1.7 ACCESS TO SITE

- .1 Provide and maintain access roads, sidewalk crossings, ramps and construction runways as may be required for access to Work.

1.8 PUBLIC TRAFFIC FLOW

- .1 Provide and maintain competent signal flag operators, traffic signals, barricades and flares, lights, or lanterns as required to perform Work and protect public.

1.9 FIRE ROUTES

- .1 Maintain access to property including overhead clearances for use by emergency response vehicles.

1.10 PROTECTION FOR OFF-SITE AND PUBLIC PROPERTY

- .1 Protect surrounding private and public property from damage during performance of Work.
- .2 Be responsible for damage incurred.

1.11 PROTECTION OF BUILDING FINISHES

- .1 Provide protection for finished and partially finished building finishes and equipment during performance of Work.
- .2 Provide necessary screens, covers, and hoardings.
- .3 Confirm with Departmental Representative locations and installation schedule 3 days prior to installation.
- .4 Be responsible for damage incurred due to lack of or improper protection.

1.12 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Waste Management and Disposal.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Within text of each specifications section, reference may be made to reference standards.
- .2 Conform to these reference standards, in whole or in part as specifically requested in specifications.
- .3 If there is question as to whether products or systems are in conformance with applicable standards, Departmental Representative reserves right to have such products or systems tested to prove or disprove conformance.
- .4 Cost for such testing will be born by Owner in event of conformance with Contract Documents or by Contractor in event of non-conformance.

1.2 QUALITY

- .1 Products, materials, equipment and articles incorporated in Work shall be new, not damaged or defective, and of best quality for purpose intended. If requested, furnish evidence as to type, source and quality of products provided.
- .2 Procurement policy is to acquire, in cost effective manner, items containing highest percentage of recycled and recovered materials practicable consistent with maintaining satisfactory levels of competition. Make reasonable efforts to use recycled and recovered materials and in otherwise utilizing recycled and recovered materials in execution of work.
- .3 Defective products, whenever identified prior to completion of Work, will be rejected, regardless of previous inspections. Inspection does not relieve responsibility, but is precaution against oversight or error. Remove and replace defective products at own expense and be responsible for delays and expenses caused by rejection.
- .4 Should disputes arise as to quality or fitness of products, decision rests strictly with Departmental Representative based upon requirements of Contract Documents.
- .5 Unless otherwise indicated in specifications, maintain uniformity of manufacture for any particular or like item throughout building.
- .6 Permanent labels, trademarks and nameplates on products are not acceptable in prominent locations, except where required for operating instructions, or when located in mechanical or electrical rooms.

1.3 AVAILABILITY

- .1 Immediately upon signing Contract, review product delivery requirements and anticipate foreseeable supply delays for items. If delays in supply of products are foreseeable, notify Departmental Representative of such, in order that substitutions or other remedial action may be authorized in ample time to prevent delay in performance of Work.
- .2 In event of failure to notify Departmental Representative at commencement of Work and should it subsequently appear that Work may be delayed for such reason, Departmental Representative reserves right to substitute more readily available products of similar character, at no increase in Contract Price or Contract Time.

1.4 STORAGE, HANDLING AND PROTECTION

- .1 Handle and store products in manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions when applicable.
- .2 Store packaged or bundled products in original and undamaged condition with manufacturer's seal and labels intact. Do not remove from packaging or bundling until required in Work.
- .3 Store products subject to damage from weather in weatherproof enclosures.
- .4 Store cementitious products clear of earth or concrete floors, and away from walls.
- .5 Keep sand, when used for grout or mortar materials, clean and dry. Store sand on wooden platforms and cover with waterproof tarpaulins during inclement weather.
- .6 Store sheet materials, lumber on flat, solid supports and keep clear of ground. Slope to shed moisture.
- .7 Store and mix paints in heated and ventilated room. Remove oily rags and other combustible debris from site daily. Take every precaution necessary to prevent spontaneous combustion.
- .8 Remove and replace damaged products at own expense and to satisfaction of Departmental Representative.
- .9 Touch-up damaged factory finished surfaces to Departmental Representative's satisfaction. Use touch-up materials to match original. Do not paint over name plates.

1.5 TRANSPORTATION

- .1 Pay costs of transportation of products required in performance of Work.

1.6 MANUFACTURER'S INSTRUCTIONS

- .1 Unless otherwise indicated in specifications, install or erect products in accordance with manufacturer's instructions. Do not rely on labels or enclosures provided with products. Obtain written instructions directly from manufacturers.
- .2 Notify Departmental Representative in writing, of conflicts between specifications and manufacturer's instructions.
- .3 Improper installation or erection of products, due to failure in complying with these requirements, authorizes Departmental Representative to require removal and re-installation at no increase in Contract Price or Contract Time.

1.7 QUALITY OF WORK

- .1 Ensure Quality of Work is of highest standard, executed by workers experienced and skilled in respective duties for which they are employed. Immediately notify Departmental Representative if required Work is such as to make it impractical to produce required results.
- .2 Do not employ anyone unskilled in their required duties. Departmental Representative reserves right to require dismissal from site, workers deemed incompetent or careless.

- .3 Decisions as to standard or fitness of Quality of Work in cases of dispute rest solely with Departmental Representative, whose decision is final.

1.8 CO-ORDINATION

- .1 Ensure co-operation of workers in laying out Work. Maintain efficient and continuous supervision.
- .2 Be responsible for coordination and placement of openings, sleeves and accessories.

1.9 CONCEALMENT

- .1 In finished areas conceal pipes, ducts and wiring in floors, walls and ceilings, except where indicated otherwise.
- .2 Before installation inform Departmental Representative if there is interference. Install as directed by Departmental Representative.

1.10 REMEDIAL WORK

- .1 Perform remedial work required to repair or replace parts or portions of Work identified as defective or unacceptable. Co-ordinate adjacent affected Work as required.
- .2 Perform remedial work by specialists familiar with materials affected. Perform in a manner to neither damage nor put at risk any portion of Work.

1.11 LOCATION OF FIXTURES

- .1 Consider location of fixtures, outlets, and mechanical and electrical items indicated as approximate.
- .2 Inform Departmental Representative of conflicting installation. Install as directed.

1.12 FASTENINGS

- .1 Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials, unless indicated otherwise.
- .2 Prevent electrolytic action between dissimilar metals and materials.
- .3 Use non-corrosive hot dip galvanized steel fasteners and anchors for securing exterior work, unless stainless steel or other material is specifically requested in affected specification Section.
- .4 Space anchors within individual load limit or shear capacity and ensure they provide positive permanent anchorage. Wood, or any other organic material plugs are not acceptable.
- .5 Keep exposed fastenings to a minimum, space evenly and install neatly.
- .6 Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.

1.13 FASTENINGS - EQUIPMENT

- .1 Use fastenings of standard commercial sizes and patterns with material and finish suitable for service.

- .2 Use heavy hexagon heads, semi-finished unless otherwise specified. Use No. 304 stainless steel for exterior areas.
- .3 Bolts may not project more than one diameter beyond nuts.
- .4 Use plain type washers on equipment, sheet metal and soft gasket lock type washers where vibrations occur. Use resilient washers with stainless steel.

1.14 PROTECTION OF WORK IN PROGRESS

- .1 Prevent overloading of parts of building. Do not cut, drill or sleeve load bearing structural member, unless specifically indicated without written approval of Departmental Representative.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 INTENT

- .1 This section indicates the criteria for use of optional products listed in the specification and provision for proposing changes to acceptable materials listed during the Bid Period and during the course of construction.

1.2 RELATED SECTIONS

- .1 Specification sections referencing this Section.

1.3 DEFINITIONS

- .1 Acceptable Materials: The term Acceptable Materials is used to specify products by trade name, manufacturer, catalogue number, model number, or similar reference, and is used within the Project Manual as follows:
 - .1 Acceptable Materials listings are based on Departmental Representative's determination that materials meet specified requirements and opinion of applicability to the project requirements.
 - .2 Acceptable Materials listings are deemed to establish the standard of acceptance that Departmental Representative will consider appropriate for the Work.
 - .3 Any product listed in the Acceptable Materials listing may be used to establish the Bid Price.
- .2 Basis-of-Design Materials: The term Basis-of-Design Materials is used to specify a specific material name, manufacturer, catalogue number, model number or similar reference and is used as follows:
 - .1 Basis-of-Design Materials are used to establish Departmental Representative's preference for a single source product listing based on performance, appearance or configuration.
 - .2 Use the Basis-of-Design Material to establish the Bid Price, unless an Addendum is issued adding additional Acceptable Materials.
 - .3 Basis-of-Design Materials designation does not limit the Contractor's ability to submit Proposed Substitutions in accordance with Substitutions requirements of this Section and specific performance requirements listed in Technical Specification Sections.
- .3 Non-proprietary specification means a specification which includes descriptive, reference standard or performance requirements, or any combination thereof, but does **not** include proprietary names of products or manufacturers.
- .4 Substitution means a proposal from a Contractor to provide a product, material, or item of equipment not specified in the Contract documents but functionally equivalent and readily exchangeable to a specified item; for consideration by Departmental Representative and Owner.

1.4 SUBMITTALS

- .1 When requested by Departmental Representative, submit complete data substantiating compliance of a product with requirements of Contract Documents. Include the following:
 - .1 Product identification, including manufacturer's name and address.

- .2 Written verification that the substitute products can be obtained, meet the performance required for the project, and meet requirements of the Building Code.
- .3 Manufacturer's literature providing product description, applicable reference standards, and performance and test data.
- .4 Samples, as applicable.
- .5 Name and address of projects on which product has been used and date of each installation.
- .6 For substitutions and requests for changes to accepted products, include in addition to the above, the following:
 - .1 Itemized comparison of substitution with named product(s). List significant variations.
 - .2 Designation of availability of maintenance services and sources of replacement materials.

1.5 PRODUCT OPTIONS

- .1 For products specified by non-proprietary specification:
 - .1 Select any product, assembly or material that meets or exceeds the specified standards for products specified only by referenced standards and performance criteria.
- .2 Acceptable Materials: Select any named product, assembly or material contained in the listing of Acceptable Materials.
- .3 Basis-of-Design Materials: Use the named product contained in the Basis-of-Design Material listing, unless an addendum is issued indicating acceptance of additional Acceptable Materials.

1.6 SUBSTITUTIONS

- .1 Contractor will assemble requests for substitutions requested by subcontractors and submit to Departmental Representative for review.
- .2 Departmental Representative will review proposed substitute products for acceptability only when submitted by Contractor; Departmental Representative will not review requests submitted independently by subcontractors.
- .3 No substitutions will be permitted without Departmental Representative's written acceptance; Contractor will be required to remove products and replace with specified materials or provide a credit to the value of the contract at Departmental Representative's discretion where substitutions are found in the Work that have not been formally accepted by Departmental Representative and Owner.
- .4 Departmental Representative is not obliged to accept any Proposed Substitution offered by Contractor, and reserves the right to dismiss any item with no further explanation.
- .5 Substitute Products: Where substitute products are permitted, unnamed products may be accepted by Departmental Representative, subject to the following:
 - .1 Substitute products shall be the same type as, be capable of performing the same functions as, and meet or exceed the standards of quality and

performance of the named product(s). Substitutions shall not require revisions to Contract Documents nor to work of Other Contractors.

- .6 Substitute Manufacturers: Where substitute manufacturers are permitted, unnamed manufacturers may be accepted by Departmental Representative, subject to the following:
 - .1 Substitute manufacturers shall have capabilities comparable to those of the named manufacturer(s). Substitutions shall not require revisions to Contract Documents nor to work of Other Contractors.
- .7 In making a proposal for substitution the Contractor represents:
 - .1 That they have personally investigated the proposal and (unless the proposal explicitly states otherwise) determined that it performs in a similar way or is superior to the product or method specified.
 - .2 That the same guaranty will be furnished as for the originally specified product or construction method.
 - .3 That they will coordinate installation of the accepted substitute into the Work, making such changes in the Work as may be required to accommodate the change.
 - .4 That they will bear costs and waives claims for additional compensation for costs and time that subsequently become apparent arising out of the substitution.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 01 11 00 – General Requirements

1.2 COORDINATION

- .1 Contractor shall coordinate Owner supplied products with the Construction Schedule for delivery dates.
- .2 Contractor shall coordinate with the Owner for installation of Owner installed items, blocking and servicing requirements and confirm dimensional requirements for items being built-in or attached to Contractor's work.
- .3 Contractor shall coordinate Owner supplied products, installed by the Contractor for installation requirements, blocking and servicing requirements and confirm dimensional requirements for items being built-in or attached to Contractor's work.
- .4 Contractor is responsible for Owner supplied items once delivered to site.

Part 3 PREPARATION

- 3.1**
- .1 Contractor shall provide all necessary framing, support and blocking built into walls (or ceiling) to receive pre-purchased equipment and furniture, all services roughing-in, in accordance with reviewed shop drawings which will be later supplied by the Owner.

- .2 Owner Supplied, Contractor Installed Materials: Contractor Manager shall receive and unload each item, transport it to its designated place of installation and unpack, assemble and install, and connect to building services, and as follows:

- .1 Owner's Responsibilities:
 - .1 Arrange for delivery of shop drawings, product data, samples, manufacturer's instructions, and certificates to Contractor.
 - .2 Deliver supplier's bill of materials to Contractor.
 - .3 Arrange and pay for delivery to site in accordance with Progress Schedule.
 - .4 Inspect deliveries jointly with Contractor.

- .5 Submit claims for transportation damage.
- .6 Arrange for replacement of damaged, defective or missing items.
- .7 Arrange for manufacturer's field services; arrange for and deliver manufacturer's warranties and bonds to Contractor.
- .2 Contractor's Responsibilities:
 - .1 Designate submittals and delivery date for each product in progress schedule.
 - .2 Review shop drawings, product data, samples, and other submittals. Submit to Departmental Representative notification of any observed discrepancies or problems anticipated due to non-conformance with Contract Documents.
 - .3 Receive and unload products at site.
 - .4 Inspect deliveries jointly with Owner; record shortages, and damaged or defective items.
 - .5 Handle products at site including un-crating and storage.
 - .6 Protect products from damage, and from exposure to elements.
 - .7 Assemble, install, connect, adjust, and finish products.
 - .8 Provide installation inspections required by public authorities.
 - .9 Repair or replace items damaged by Contractor or Subcontractor on site (under their control).

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Owner's identification of existing survey control points and property limits.

1.2 QUALIFICATIONS OF SURVEYOR

- .1 Qualified registered land surveyor, licensed to practice in Place of Work, acceptable to Departmental Representative.

1.3 SURVEY REFERENCE POINTS

- .1 Existing base horizontal and vertical control points are designated on drawings.
- .2 Locate, confirm and protect control points prior to starting site work. Preserve permanent reference points during construction.
- .3 Make no changes or relocations without prior written notice to Departmental Representative.
- .4 Report to Departmental Representative when reference point is lost or destroyed, or requires relocation because of necessary changes in grades or locations.
- .5 Require surveyor to replace control points in accordance with original survey control.

1.4 SURVEY REQUIREMENTS

- .1 Establish two permanent bench marks on site, referenced to established bench marks by survey control points. Record locations, with horizontal and vertical data in Project Record Documents.
- .2 Establish lines and levels, locate and lay out, by instrumentation.
- .3 Stake for grading, fill and topsoil placement and landscaping features.
- .4 Stake slopes and berms.
- .5 Establish pipe invert elevations.
- .6 Stake batter boards for foundations.
- .7 Establish foundation column locations and floor elevations.
- .8 Establish lines and levels for mechanical and electrical work.

1.5 EXISTING SERVICES

- .1 Before commencing work, establish location and extent of service lines in area of Work and notify Departmental Representative of findings.
- .2 Remove abandoned service lines within 2 m of structures. Cap or otherwise seal lines at cut-off points as directed by Departmental Representative.

1.6 LOCATION OF EQUIPMENT AND FIXTURES

- .1 Location of equipment, fixtures and outlets indicated or specified are to be considered as approximate.
- .2 Locate equipment, fixtures and distribution systems to provide minimum interference and maximum usable space and in accordance with manufacturer's recommendations for safety, access and maintenance.

- .3 Inform Departmental Representative of impending installation and obtain approval for actual location.
- .4 Submit field drawings to indicate relative position of various services and equipment when required by Departmental Representative.

1.7 RECORDS

- .1 Maintain a complete, accurate log of control and survey work as it progresses.
- .2 On completion of foundations and major site improvements, prepare a certified survey showing dimensions, locations, angles and elevations of Work.
- .3 Record locations of maintained, re-routed and abandoned service lines.

1.8 SUBMITTALS

- .1 Submit name and address of Surveyor to Departmental Representative.
- .2 On request of Departmental Representative, submit documentation to verify accuracy of field engineering work.
- .3 Submit certificate signed by surveyor certifying and noting those elevations and locations of completed Work that conform and do not conform with Contract Documents.

1.9 SUBSURFACE CONDITIONS

- .1 Promptly notify Departmental Representative in writing if subsurface conditions at Place of Work differ materially from those indicated in Contract Documents, or a reasonable assumption of probable conditions based thereon.
- .2 After prompt investigation, should Departmental Representative determine that conditions do differ materially, instructions will be issued for changes in Work as provided in Changes and Change Orders.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit written request in advance of cutting or alteration which affects:
 - .1 Structural integrity of elements of project.
 - .2 Integrity of weather-exposed or moisture-resistant elements.
 - .3 Efficiency, maintenance, or safety of operational elements.
 - .4 Visual qualities of sight-exposed elements.
 - .5 Work of Owner or separate contractor.
- .3 Include in request:
 - .1 Identification of project.
 - .2 Location and description of affected Work.
 - .3 Statement on necessity for cutting or alteration.
 - .4 Description of proposed Work, and products to be used.
 - .5 Alternatives to cutting and patching.
 - .6 Effect on Work of Owner or separate contractor.
 - .7 Written permission of affected separate contractor.
 - .8 Date and time work will be executed.

1.2 MATERIALS

- .1 Required for original installation.
- .2 Change in Materials: Submit request for substitution in accordance with Section 01 62 00 – Product Options and Substitutions.

1.3 PREPARATION

- .1 Inspect existing conditions, including elements subject to damage or movement during cutting and patching.
- .2 After uncovering, inspect conditions affecting performance of Work.
- .3 Beginning of cutting or patching means acceptance of existing conditions.
- .4 Provide supports to assure structural integrity of surroundings; provide devices and methods to protect other portions of project from damage.
- .5 Provide protection from elements for areas which are to be exposed by uncovering work; maintain excavations free of water.

1.4 EXECUTION

- .1 Execute cutting, fitting, and patching including excavation and fill, to complete Work.
- .2 Fit several parts together, to integrate with other Work.
- .3 Uncover Work to install ill-timed Work.
- .4 Remove and replace defective and non-conforming Work.
- .5 Remove samples of installed Work for testing.

- .6 Provide openings in non-structural elements of Work for penetrations of mechanical and electrical Work.
- .7 Execute Work by methods to avoid damage to other Work, and which will provide proper surfaces to receive patching and finishing.
- .8 Employ original installer to perform cutting and patching for weather-exposed and moisture-resistant elements, and sight-exposed surfaces.
- .9 Cut rigid materials using masonry saw or core drill. Pneumatic or impact tools not allowed on masonry work without prior approval.
- .10 Restore work with new products in accordance with requirements of Contract Documents.
- .11 Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- .12 At penetration of fire rated wall, ceiling, or floor construction, completely seal voids with firestopping material in accordance with Section 07 84 00 - Firestopping, full thickness of the construction element.
- .13 Refinish surfaces to match adjacent finishes: Refinish continuous surfaces to nearest intersection. Refinish assemblies by refinishing entire unit.
- .14 Conceal pipes, ducts and wiring in floor, wall and ceiling construction of finished areas except where indicated otherwise.

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Waste Management and Disposal.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 PROJECT CLEANLINESS

- .1 Maintain Work in tidy condition, free from accumulation of waste products and debris, including that caused by Owner or other Contractors.
- .2 Remove waste materials from site at daily regularly scheduled times or dispose of as directed by Departmental Representative. Do not burn waste materials on site, unless approved by Departmental Representative.
- .3 Clear snow and ice from access to building, bank/pile snow in designated areas only.
- .4 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .5 Provide on-site containers for collection of waste materials and debris.
- .6 Provide and use marked separate bins for recycling. Refer to Section 01 74 21 - Waste Management and Disposal.
- .7 Dispose of waste materials and debris off site.
- .8 Clean interior areas prior to start of finishing work, and maintain areas free of dust and other contaminants during finishing operations.
- .9 Store volatile waste in covered metal containers, and remove from premises at end of each working day.
- .10 Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.
- .11 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.
- .12 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

1.2 FINAL CLEANING

- .1 Clean work prior to final review by Departmental Representative.
- .2 When Work is Substantially Performed remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.
- .3 Remove waste in accordance with Section 01 74 21 – Waste Management and Disposal.
- .4 Remove waste products and debris other than that caused by others, and leave Work clean and suitable for occupancy.
- .5 Prior to final review remove surplus products, tools, construction machinery and equipment.
- .6 Remove waste products and debris including that caused by Owner or other Contractors.

- .7 Remove waste materials from site at regularly scheduled times or dispose of as directed by Departmental Representative. Do not burn waste materials on site, unless approved by Departmental Representative.
- .8 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .9 Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, and mechanical and electrical fixtures. Replace broken, scratched or disfigured glass.
- .10 Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, furniture fitments, walls, and floors.
- .11 Clean lighting reflectors, lenses, and other lighting surfaces.
- .12 Vacuum clean and dust building interiors, behind grilles, louvres and screens.
- .13 Wax, seal, shampoo or prepare floor finishes, as recommended by manufacturer.
- .14 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.
- .15 Broom clean and wash exterior walks, steps and surfaces; rake clean other surfaces of grounds.
- .16 Remove dirt and other disfiguration from exterior surfaces.
- .17 Clean and sweep roofs, gutters, areaways, and sunken wells.
- .18 Sweep and wash clean paved areas.
- .19 Clean equipment and fixtures to sanitary condition.
- .20 Clean mechanical equipment including replacement of filters in accordance with Section 01 47 18 – Indoor Air Quality.
- .21 Clean roofs, downspouts, and drainage systems.
- .22 Remove debris and surplus materials from crawl areas and other accessible concealed spaces.
- .23 Remove snow and ice from access to building.

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Waste Management and Disposal.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 WASTE MANAGEMENT GOALS

- .1 Prior to start of Work conduct meeting with Departmental Representative to review and discuss Waste Management Plan and Goals.
- .2 Waste Management Goal: 75 percent of total Project Waste to be diverted from landfill sites. Provide Departmental Representative documentation certifying that waste management, recycling, reuse of recyclable and reusable materials have been extensively practiced.
- .3 Accomplish maximum control of solid construction waste.
- .4 Preserve environment and prevent pollution and environment damage.

1.2 DEFINITIONS

- .1 Class III: non-hazardous waste - construction renovation and demolition waste.
- .2 Inert Fill: inert waste - exclusively asphalt and concrete.
- .3 Materials Source Separation Program (MSSP): consists of series of ongoing activities to separate reusable and recyclable waste material into material categories from other types of waste at point of generation.
- .4 Recyclable: ability of product or material to be recovered at end of its life cycle and re-manufactured into new product for reuse.
- .5 Recycle: process by which waste and recyclable materials are transformed or collected for purpose of being transferred into new products.
- .6 Recycling: process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for purpose of using in altered form. Recycling does not include burning, incinerating, or thermally destroying waste.
- .7 Reuse: repeated use of product in same form but not necessarily for same purpose. Reuse includes:
 - .1 Salvaging reusable materials from re-modelling projects, before demolition stage, for resale, reuse on current project or for storage for use on future projects.
 - .2 Returning reusable items including pallets or unused products to vendors.
- .8 Salvage: removal of structural and non-structural materials from deconstruction/disassembly projects for purpose of reuse or recycling.
- .9 Separate Condition: refers to waste sorted into individual types.
- .10 Source Separation: acts of keeping different types of waste materials separate beginning from first time they became waste.

1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit before final payment summary of waste materials salvaged for reuse, recycling or disposal by project using deconstruction/disassembly material audit form.
 - .1 Failure to submit could result in hold back of final payment.

- .2 Provide receipts, scale tickets, waybills, and show quantities and types of materials reused, recycled, co-mingled and separated off-site or disposed of.
- .3 For each material reused, sold or recycled from project, include amount in tonnes and the destination.
- .4 For each material land filled or incinerated from project, include amount in tonnes of material and identity of landfill, incinerator or transfer station.

1.4 MATERIALS SOURCE SEPARATION PROGRAM (MSSP)

- .1 Prepare MSSP and have ready for use prior to project start-up.
- .2 Implement MSSP for waste generated on project in compliance with approved methods and as reviewed by Departmental Representative.
- .3 Provide on-site facilities for collection, handling, and storage of anticipated quantities of reusable and recyclable materials.
- .4 Provide containers to deposit reusable and recyclable materials.
- .5 Locate containers in locations, to facilitate deposit of materials without hindering daily operations.
- .6 Locate separated materials in areas which minimize material damage.
- .7 Collect, handle, store on-site, and transport off-site, salvaged materials in separate condition.
 - .1 Transport to approved and authorized recycling facility.
- .8 Collect, handle, store on-site, and transport off-site, salvaged materials in combined condition.
 - .1 Ship materials to site operating under Certificate of Approval.
 - .2 Materials must be immediately separated into required categories for reuse or recycling.

1.5 STORAGE, HANDLING AND PROTECTION

- .1 Store, materials to be reused, recycled and salvaged in locations as directed by Departmental Representative.
- .2 Unless specified otherwise, materials for removal become Contractor's property.
- .3 Protect, stockpile, store and catalogue salvaged items.
- .4 Separate non-salvageable materials from salvaged items. Transport and deliver non-salvageable items to licensed disposal facility.
- .5 Protect surface drainage, mechanical and electrical from damage and blockage.
- .6 Separate and store materials produced during dismantling of structures in designated areas.
- .7 Prevent contamination of materials to be salvaged and recycled and handle materials in accordance with requirements for acceptance by designated facilities.
 - .1 On-site source separation is recommended.
 - .2 Remove co-mingled materials to off-site processing facility for separation.
 - .3 Provide waybills for separated materials.

1.6 DISPOSAL OF WASTES

- .1 Do not bury rubbish or waste materials.
- .2 Do not dispose of waste, volatile materials, mineral spirits, oil, and paint thinner into waterways, storm, or sanitary sewers.
- .3 Keep records of construction waste including:
 - .1 Number and size of bins.
 - .2 Waste type of each bin.
 - .3 Total tonnage generated.
 - .4 Tonnage reused or recycled.
 - .5 Reused or recycled waste destination.
- .4 Remove materials from deconstruction as deconstruction/disassembly Work progresses.
- .5 Prepare project summary to verify destination and quantities on a material-by-material basis as identified in pre-demolition material audit.

1.7 USE OF SITE AND FACILITIES

- .1 Execute work with least possible interference or disturbance to normal use of premises.
- .2 Provide temporary security measures approved by Departmental Representative.

1.8 SCHEDULING

- .1 Co-ordinate Work with other activities at site to ensure timely and orderly progress of Work.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 APPLICATION

- .1 Do Work in compliance with WRW.
- .2 Handle waste materials not reused, salvaged, or recycled in accordance with appropriate regulations and codes.

3.2 CLEANING

- .1 Remove tools and waste materials on completion of Work, and leave work area in clean and orderly condition.
- .2 Clean-up work area as work progresses.
- .3 Source separate materials to be reused/recycled into specified sort areas.

3.3 DIVERSION OF MATERIALS

- .1 From following list, separate materials from general waste stream and stockpile in separate piles or containers, as reviewed by Departmental Representative, and consistent with applicable fire regulations.
 - .1 Mark containers or stockpile areas.
 - .2 Provide instruction on disposal practices.
- .2 On-site sale of recovered and recyclable material is not permitted.

3.4 CANADIAN GOVERNMENTAL DEPARTMENTS CHIEF RESPONSIBILITY FOR THE ENVIRONMENT

- .1 Schedule E - Government Chief Responsibility for the Environment:

Province	Address	General Inquires	Fax
British Columbia	Ministry of Environment Lands and Parks 810 Blanshard Street, 4 th Floor Victoria BC V8V 1X4	604-387-1161	604-356-6464
	Waste Reduction Commission Soils and Hazardous Waste 770 South Pacific Blvd, Suite 303 Vancouver BC V6B 5E7	604-660-9550	604-660-9596

END OF SECTION

Part 1 General

1.1 INTENT

- .1 A facility start-up process shall be used to bring the facility to a fully operational state, free of deficiencies, in the most efficient and timely manner achievable.
- .2 Contractor shall be responsible for testing, adjusting and balancing of all:
 - .1 Piped, ducted, wired and wireless services and systems, including all components and equipment forming part thereof, and
 - .2 Manually and mechanically operated systems including all components and equipment forming part thereof.
- .3 Perform starting of each system and each item of equipment in accordance with the general requirements specified in this section and is specific to facility start-up and commissioning of the facility.
- .4 This section specifies additional requirements to those required for normal Contractor's start-up of equipment and systems as contained in the General Requirements of the Contract, and as follows:
 - .1 Perform and record tests to confirm proper performance and compliance with requirements of Contract Documents; take corrective action as necessary.
 - .2 Perform adjustments to ensure proper, efficient and safe operation.
 - .3 Perform balancing to ensure that the various parts of system are in a proper state of equilibrium.
- .5 Performance Testing will begin after declaration of Substantial Performance as described in Section 01 77 00 – Closeout Procedures and will lead to Fine Tuning of equipment and systems.
- .6 Fine Tuning will occur after declaration of Substantial Performance as described in Section 01 77 00 – Closeout Procedures and will lead to Final Acceptance of the Work.

1.2 RELATED SECTIONS

- .1 Section 01 77 00 – Closeout Procedures
- .2 Section 01 79 00 – Demonstration and Training

1.3 QUALITY ASSURANCE

- .1 Contractor shall perform testing, adjusting and balancing with Contractor's qualified personnel, or employ and pay for a qualified organization to perform such services.
- .2 Perform testing, adjusting and balancing after starting of equipment and systems.
- .3 Provide personnel, operate systems at designated times, and under conditions required for proper testing, adjusting, and balancing.
- .4 Report to Departmental Representative any deficiencies or defects noted during testing, adjusting and balancing, which cannot be promptly corrected.

Part 2 Products

2.1 MANUFACTURER'S SITE SERVICES

- .1 Provide manufacturers authorized representative when specified, or when requested by the Owner at site to do the following:
 - .1 Inspect, check and approve equipment and systems installation before starting.
 - .2 Supervise placing equipment and systems in operation.
- .2 Manufacturers' authorized representative shall provide a written report verifying that equipment:
 - .1 Is properly installed and lubricated;
 - .2 Is in accurate alignment;
 - .3 Is free from any undue stress imposed by connecting lines or anchor bolts; and,
 - .4 Is being satisfactorily operated under load conditions.

Part 3 Execution

3.1 PREPARATION

- .1 Have Contract Documents, shop drawings, product data, and operation and maintenance data at hand during starting process.
- .2 Coordinate sequence for starting of various equipment and systems.
- .3 Prepare each system and item of equipment for testing, adjusting and balancing.
- .4 Verify that each systems and equipment installation is complete and in continuous operation.
- .5 Verify ambient conditions.

3.2 FACILITY START-UP

- .1 Contractor shall do the following during Facility Start-Up, not necessarily in order listed:
 - .1 Start equipment and systems as specified below.
 - .2 Test, adjust and balance equipment and systems as specified below.
 - .3 Demonstrate equipment and systems as specified in Section 01 79 00 – Demonstration and Training.
 - .4 Complete and submit Facility Start-Up report forms including:
 - .1 Contractor's system and equipment start-up reports.
 - .2 Testing, adjusting and balancing reports.
 - .3 Manufacturers' equipment start-up reports.
 - .5 Review Contract Documents and inspect the Work to ensure completeness of the Work and compliance with requirements of Contract Documents.
 - .6 Correct Contract Deficiencies identified as a result of the foregoing and as may be identified by the Owner.

- .7 Execute Change Orders issued by the Owner.
- .8 Perform all other work and activities required for fulfillment of prerequisites to Substantial Performance of the Work as specified in Section 01 77 00.

3.3 STARTING

- .1 Verify that each item of equipment has been checked for proper lubrication; drive rotation, belt tension, control sequence, and other conditions affecting starting and operation; take corrective action as necessary.
- .2 Execute starting under supervision of Contractor's personnel and, when specified or requested by Owner, manufacturer's authorized representative.
- .3 Place equipment and systems in operation in proper sequence and in accordance with approved Contractor's Start-Up sub-schedule.
- .4 Take corrective action as necessary.

3.4 TESTING, ADJUSTING AND BALANCING

- .1 Testing: Perform tests to confirm compliance with requirements of Contract Documents. Take corrective action as necessary.
- .2 Adjusting: Perform adjustments to ensure proper, efficient and safe operation.
- .3 Balancing: Perform balancing to ensure that the various parts of system are in a proper state of equilibrium.
- .4 Provide testing, adjusting and balancing of all:
 - .1 Piped, ducted, wired and wireless services and systems, including all components and equipment forming part thereof as identified in technical sections, and
 - .2 Manually and mechanically operated systems including all components and equipment forming part thereof.
 - .3 Comply with the requirements of all CSA, ASTM, ASHRAE, IEEE and other standards affecting their portion of the work to ensure that systems installed will meet the Owner's testing criteria.
 - .4 Copies of required standards shall be kept on site during installation and be available for viewing by the Contractor, the Departmental Representative and the Owner.
- .5 Perform testing, adjusting and balancing after starting of equipment and systems.

3.5 FINE TUNING

- .1 Fine tuning shall include, but not be limited to, the following:
 - .1 Air Balancing: final balancing.
 - .2 Water Balancing: final balancing.
 - .3 Fire Protection Systems: Verification of fire alarm system.
 - .4 Electrical Equipment and Systems: Testing of safety systems and devices.
 - .5 Other systems and equipment as identified in the technical sections.

- .2 Fine tuning shall commence upon Owner's acceptance of Performance Testing results.
- .3 Coordinate and cooperate with the Owner's Representative.
- .4 Make necessary adjustments to comply with standards established by the Specifications ready for Owner's formalized verification and commissioning process.
- .5 Contractor shall do the following during Fine Tuning:
 - .1 Correct all Contract Deficiencies previously outstanding and those identified during Fine Tuning.
 - .2 Execute Change Orders issued by Owner.
 - .3 Perform all other work and activities required for fulfillment of prerequisites to Final Acceptance of the Work as specified in Section 01 77 00.
- .6 Owner will do the following during Fine Tuning:
 - .1 Conduct user surveys and take environmental measurements as necessary to identify existing and potential problems.
 - .2 Initiate Change Orders as required.
 - .3 Perform other activities related to Final Acceptance of the Work as specified in Section 01 77 00.

3.6 SEASONAL CONSTRAINTS

- .1 Notwithstanding all-inclusive requirements specified in this Section, additional separate cycles of Facility Start-Up, Performance Testing and Fine Tuning may be necessitated at a later time on equipment and systems whose full operation is dependent on seasonal conditions.
- .2 Contractor's responsibilities with respect to such later Facility Start-Up activities shall be as specified in this Section.

3.7 PARTIAL UTILIZATION OF WORK

- .1 Applicable requirements specified in this Section shall apply to the parts of the Work being utilized when partial utilization of the Work is required.

END OF SECTION

Part 1 General

1.1 INSPECTION AND DECLARATION

- .1 Contractor's Inspection: Contractor and Subcontractors: conduct inspection of Work, identify deficiencies and defects, and repair as required to conform to Contract Documents.
 - .1 Notify Departmental Representative in writing of satisfactory completion of Contractor's inspection and that corrections have been made.
 - .2 Request Departmental Representative's review.
 - .3 Departmental Representative's Review: Departmental Representative and Contractor will perform inspection of Work to identify obvious defects or deficiencies. Contractor to correct Work accordingly.
- .2 Completion: submit written certificate that following have been performed:
 - .1 Work has been completed and inspected for compliance with Contract Documents.
 - .2 Defects have been corrected and deficiencies have been completed.
 - .3 Equipment and systems have been tested, adjusted and balanced and are fully operational.
 - .4 Certificates required by Boiler Inspection Branch, Fire Commissioner and Utility companies have been submitted.
 - .5 Operation of systems have been demonstrated to Owner's personnel.
 - .6 Work is complete and ready for final inspection.
- .3 Final Review: when items noted above are completed, request final inspection of Work by Owner, Departmental Representative, and Contractor. If Work is deemed incomplete by Owner and Departmental Representative, complete outstanding items and request reinspection.
- .4 Commencement of Lien and Warranty Periods: date of Owner's acceptance of submitted declaration of Substantial Performance shall be date for commencement for warranty period and commencement of lien period unless required otherwise by lien statute of Place of Work.

1.2 CLEANING

- .1 In accordance with Section 01 74 11 – Cleaning.
- .2 Remove waste and surplus materials, rubbish and construction facilities from the site in accordance with Section 01 74 21 - Waste Management and Disposal.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Prepare instructions and data using personnel experienced in maintenance and operation of described products.
- .3 Copy will be returned after final review, with Departmental Representative's comments.
- .4 Revise content of documents as required prior to final submittal.
- .5 Two weeks prior to Substantial Performance of the Work, submit to the Departmental Representative, two final copies of operating and maintenance manuals in English along with pdf version on a flash drive in English.
- .6 Ensure spare parts, maintenance materials and special tools provided are new, undamaged or defective, and of same quality and manufacture as products provided in Work.
- .7 Furnish evidence, if requested, for type, source and quality of products provided.
- .8 Defective products will be rejected, regardless of previous inspections. Replace products at own expense.
- .9 Pay costs of transportation.
- .10 Submit `redline` marked up construction drawings to the Departmental Representative within 30 days of Substantial Performance and prior to final completion.

1.2 FORMAT

- .1 Organize data as instructional manual.
- .2 Binders: hard covered, 3 'D' ring, loose leaf 219 x 279 mm with spine and face pockets.
- .3 When multiple binders are used correlate data into related consistent groupings. Identify contents of each binder on spine.
- .4 Cover: identify each binder with type or printed title 'Project Record Documents'; list title of project and identify subject matter of contents.
- .5 Arrange content by systems, process flow, under Section numbers and sequence of Table of Contents.
- .6 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.
- .7 Text: manufacturer's printed data, or typewritten data.
- .8 Drawings: provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

1.3 CONTENTS - EACH VOLUME

- .1 Table of Contents: provide title of project;
 - .1 Date of submission; names.

- .2 Addresses, and telephone numbers of Departmental Representative and Contractor with name of responsible parties.
- .3 Schedule of products and systems, indexed to content of volume.
- .2 For each product or system:
 - .1 List names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.
- .3 Product Data: mark each sheet to identify specific products and component parts, and data applicable to installation; delete inapplicable information.
- .4 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.
- .5 Typewritten Text: as required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Section 01 45 00 - Quality Control.
- .6 Training: refer to Section 01 79 00 - Demonstration and Training.

1.4 AS-BUILTS AND SAMPLES

- .1 Maintain, in addition to requirements in General Conditions, at site for Departmental Representative one record copy of:
 - .1 Contract Drawings.
 - .2 Specifications.
 - .3 Addenda.
 - .4 Change Orders and other modifications to Contract.
 - .5 Reviewed shop drawings, product data, and samples.
 - .6 Field test records.
 - .7 Inspection certificates.
 - .8 Manufacturer's certificates.
- .2 Store record documents and samples in field office apart from documents used for construction. Provide files, racks, and secure storage.
- .3 Label record documents and file in accordance with Section number listings in List of Contents of this Project Manual. Label each document "PROJECT RECORD" in neat, large, printed letters.
- .4 Maintain record documents in clean, dry and legible condition. Do not use record documents for construction purposes.
- .5 Keep record documents and samples available for inspection by Departmental Representative.

1.5 RECORDING ACTUAL SITE CONDITIONS

- .1 Record information on set of drawings, and in copy of Project Manual, provided by Departmental Representative.
- .2 Provide felt tip marking pens, maintaining separate colours for each major system, for recording information.
- .3 Record information concurrently with construction progress. Do not conceal Work until required information is recorded.

- .4 Contract Drawings and shop drawings: mark each item to record actual construction, including:
 - .1 Measured depths of elements of foundation in relation to finish first floor datum.
 - .2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - .3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.
 - .4 Field changes of dimension and detail.
 - .5 Changes made by change orders.
 - .6 Details not on original Contract Drawings.
 - .7 References to related shop drawings and modifications.
- .5 Specifications: mark each item to record actual construction, including:
 - .1 Manufacturer, trade name, and catalogue number of each product actually installed, particularly optional items and substitute items.
 - .2 Changes made by Addenda and change orders.
- .6 Other Documents: maintain manufacturer's certifications, inspection certifications, field test records, required by individual specifications sections.

1.6 FINAL SURVEY

- .1 Submit final site survey certificate in accordance with Section 01 71 00 - Examination and Preparation, certifying that elevations and locations of completed Work are in conformance, or non-conformance with Contract Documents.

1.7 REAL PROPERTY CERTIFICATE

- .1 Supply to the Departmental Representative, as soon as construction of foundations and basic ground floor levels are completed, a survey plan from a registered British Columbia Land Surveyor.
- .2 Plan shall show dimensioned building plan at ground level, distance from property lines, and elevation of the floor used as datum.
- .3 This includes all buildings in Contract.

1.8 EQUIPMENT AND SYSTEMS

- .1 Each Item of Equipment and Each System: include description of unit or system, and component parts. Give function, normal operation characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
- .2 Panel board circuit directories: provide electrical service characteristics, controls, and communications.
- .3 Include installed colour coded wiring diagrams.
- .4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.

- .5 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- .6 Provide servicing and lubrication schedule, and list of lubricants required.
- .7 Include manufacturer's printed operation and maintenance instructions.
- .8 Include sequence of operation by controls manufacturer.
- .9 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- .10 Provide installed control diagrams by controls manufacturer.
- .11 Provide Contractor's co-ordination drawings, with installed colour coded piping diagrams.
- .12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- .13 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- .14 Include test and balancing reports as specified in Section 01 45 00 - Quality Control.
- .15 Additional requirements: as specified in individual specification sections.

1.9 MATERIALS AND FINISHES

- .1 Building Products, Applied Materials, and Finishes: include product data, with catalogue number, size, composition, and colour and texture designations. Provide information for re-ordering custom manufactured products.
- .2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .3 Moisture-Protection and Weather-Exposed Products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .4 Additional Requirements: as specified in individual specifications sections.

1.10 SPARE PARTS

- .1 Provide spare parts, in quantities specified in individual specification sections.
- .2 Provide items of same manufacture and quality as items in Work.
- .3 Deliver to site, location as directed; place and store.
- .4 Receive and catalogue items. Submit inventory listing to Departmental Representative. Include approved listings in Maintenance Manual.
- .5 Obtain receipt for delivered products and submit prior to final payment.

1.11 MAINTENANCE MATERIALS

- .1 Provide maintenance and extra materials, in quantities specified in individual specification sections.

- .2 Provide items of same manufacture and quality as items in Work.
- .3 Deliver to site, location as directed; place and store.
- .4 Receive and catalogue items. Submit inventory listing to Departmental Representative. Include approved listings in Maintenance Manual.
- .5 Obtain receipt for delivered products and submit prior to final payment.

1.12 EXITING SIGNAGE

- .1 Provide computer generated signage for emergency passage exiting of building. Provide minimum 305 x 305 mm size signs to include at locations as required by Authority having Jurisdiction for building exiting.

1.13 SPECIAL TOOLS

- .1 Provide special tools, in quantities specified in individual specification section.
- .2 Provide items with tags identifying their associated function and equipment.
- .3 Deliver to site, location as directed; place and store.
- .4 Receive and catalogue items. Submit inventory listing to Departmental Representative. Include approved listings in Maintenance Manual.

1.14 STORAGE, HANDLING AND PROTECTION

- .1 Store spare parts, maintenance materials, and special tools in manner to prevent damage or deterioration.
- .2 Store in original and undamaged condition with manufacturer's seal and labels intact.
- .3 Store components subject to damage from weather in weatherproof enclosures.
- .4 Store paints and freezable materials in a heated and ventilated room.
- .5 Remove and replace damaged products at own expense and to satisfaction of Departmental Representative.

1.15 WARRANTIES AND BONDS

- .1 Develop warranty management plan to contain information relevant to Warranties.
- .2 Submit warranty management plan, 30 days before planned pre-warranty conference, to Departmental Representative approval.
- .3 Warranty management plan to include required actions and documents to assure that Owner receives warranties to which it is entitled.
- .4 Provide plan in narrative form and contain sufficient detail to make it suitable for use by future maintenance and repair personnel.
- .5 Submit, warranty information made available during construction phase, to Departmental Representative for approval prior to each monthly pay estimate.
- .6 Assemble approved information in binder and submit upon acceptance of work. Organize binder as follows:
 - .1 Separate each warranty or bond with index tab sheets keyed to Table of Contents listing.

- .2 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.
- .3 Obtain warranties and bonds, executed in duplicate by subcontractors, suppliers, and manufacturers, within ten days after completion of applicable item of work.
- .4 Verify that documents are in proper form, contain full information, and are notarized.
- .5 Co-execute submittals when required.
- .6 Retain warranties and bonds until time specified for submittal.
- .7 Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial Performance is determined.
- .8 Conduct joint 4 month and 9 month warranty inspection, measured from time of acceptance, by Departmental Representative.
- .9 Include information contained in warranty management plan as follows:
 - .1 Roles and responsibilities of personnel associated with warranty process, including points of contact and telephone numbers within the organizations of Contractors, subcontractors, manufacturers or suppliers involved.
 - .2 Listing and status of delivery of Certificates of Warranty for extended warranty items, to include roofs, HVAC balancing, pumps, motors, transformers such as fire protection, alarm systems, sprinkler systems, and lightning protection systems.
 - .3 Provide list for each warranted equipment, item, feature of construction or system indicating:
 - .1 Name of item.
 - .2 Model and serial numbers.
 - .3 Location where installed.
 - .4 Name and phone numbers of manufacturers or suppliers.
 - .5 Names, addresses and telephone numbers of sources of spare parts.
 - .6 Warranties and terms of warranty: include one-year overall warranty of construction. Indicate items that have extended warranties and show separate warranty expiration dates.
 - .7 Cross-reference to warranty certificates as applicable.
 - .8 Starting point and duration of warranty period.
 - .9 Summary of maintenance procedures required to continue warranty in force.
 - .10 Cross-Reference to specific pertinent Operation and Maintenance manuals.
 - .11 Organization, names and phone numbers of persons to call for warranty service.
 - .12 Typical response time and repair time expected for various warranted equipment.
 - .4 Contractor's plans for attendance at 4 and 9 month post-construction warranty inspections.

- .5 Procedure and status of tagging of equipment covered by extended warranties.
- .6 Post copies of instructions near selected pieces of equipment where operation is critical for warranty and/or safety reasons.
- .10 Respond in a timely manner to oral or written notification of required construction warranty repair work.
- .11 Written verification will follow oral instructions. Failure to respond will be cause for the Departmental Representative to proceed with action against Contractor.

1.16 PRE-WARRANTY CONFERENCE

- .1 Meet with Departmental Representative, to develop understanding of requirements of this section. Schedule meeting prior to contract completion, and at time designated by Departmental Representative.
- .2 Departmental Representative will establish communication procedures for:
 - .1 Notification of construction warranty defects.
 - .2 Determine priorities for type of defect.
 - .3 Determine reasonable time for response.
- .3 Provide name, telephone number and address of licensed and bonded company that is authorized to initiate and pursue construction warranty work action.
- .4 Ensure contact is located within local service area of warranted construction, is continuously available, and is responsive to inquiries for warranty work action.

1.17 WARRANTY TAGS

- .1 Tag, at time of installation, each warranted item. Provide durable, oil and water resistant tag approved by Departmental Representative.
- .2 Attach tags with copper wire and spray with waterproof silicone coating.
- .3 Leave date of acceptance until project is accepted for occupancy.
- .4 Indicate following information on tag:
 - .1 Type of product/material.
 - .2 Model number.
 - .3 Serial number.
 - .4 Contract number.
 - .5 Warranty period.
 - .6 Inspector's signature.
 - .7 Construction Contractor.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 DESCRIPTION

- .1 Demonstrate scheduled operation and maintenance of equipment and systems to Owner's personnel two weeks prior to date of [final inspection] [substantial performance] [interim completion].
- .2 Owner will provide list of personnel to receive instructions, and will co-ordinate their attendance at agreed-upon times.

1.2 QUALITY CONTROL

- .1 When specified in individual Sections require manufacturer to provide authorized representative to demonstrate operation of equipment and systems, instruct Owner's personnel, and provide written report that demonstration and instructions have been completed.

1.3 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit schedule of time and date for demonstration of each item of equipment and each system two weeks prior to designated dates, for Departmental Representative's approval.
- .3 Submit reports within one week after completion of demonstration, that demonstration and instructions have been satisfactorily completed.
- .4 Give time and date of each demonstration, with list of persons present.

1.4 CONDITIONS FOR DEMONSTRATIONS

- .1 Equipment has been inspected and put into operation.
- .2 Testing, adjusting, and balancing has been performed in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements and equipment and systems are fully operational.
- .3 Provide copies of completed operation and maintenance manuals for use in demonstrations and instructions.

1.5 PREPARATION

- .1 Verify that conditions for demonstration and instructions comply with requirements.
- .2 Verify that designated personnel are present.

1.6 DEMONSTRATION AND INSTRUCTIONS

- .1 Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, and maintenance of each item of equipment at scheduled times, at the equipment location.
- .2 Instruct personnel in phases of operation and maintenance using operation and maintenance manuals as basis of instruction.
- .3 Review contents of manual in detail to explain aspects of operation and maintenance.

- .4 Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instructions.

1.7 TIME ALLOCATED FOR INSTRUCTIONS

- .1 Ensure amount of time required for instruction of each item of equipment or system as follows:
 - .1 Heating Plant: as required.
 - .2 Cooling and Ventilation System: as required.
 - .3 Control System: as required.
 - .4 Plumbing System: as required.
 - .5 Electrical System: as required.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 U.S. Environmental Protection Agency (EPA) / Office of Water
 - .1 EPA 832/R-92-005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 — Submittal Procedures.

Part 2 Products

2.1 EQUIPMENT

- .1 Where applicable, use cold milling, planning or grinding equipment with automatic grade controls capable of operating from stringline, and capable of removing part of pavement surface to depths or grades indicated.

Part 3 Execution

3.1 PREPARATION

- .1 Temporary Erosion and Sedimentation Control:
 - .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.
 - .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
 - .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
- .2 Prior to beginning removal operation, inspect and verify with Departmental Representative areas, depths and lines of asphalt pavement to be removed.
- .3 Protection: protect existing pavement not designated for removal, light units and structures from damage. In event of damage, immediately replace or make repairs to approval of Departmental Representative at no additional cost.

3.2 REMOVAL

- .1 Remove existing asphalt pavement to lines and grades as indicated by Departmental Representative and drawings.

- .2 Use equipment and methods of removal and hauling which do not damage or disturb underlying pavement.
- .3 Prevent contamination of removed asphalt pavement by topsoil, underlying gravel or other materials.
- .4 Suppress dust generated by removal process.
 - .1 Use non-petroleum based dust control methods only
- .5 Asphalt removed to be transported to Beaver Pit and crushed into base aggregate — not for reuse on this project.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Sweep remaining asphalt pavement surfaces clean of debris resulting from removal operations using rotary power brooms and hand brooming as required.
- .4 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 — Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.
 - .2 Removed asphalt pavement which is to be recycled in hot mix asphalt concrete under this contract may be stockpiled at designated asphalt plant site.

END OF SECTION

Part 1 General**1.1 DOCUMENTS**

- .1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 DESCRIPTION OF WORK INCLUDED

- .1 Provide all labour, materials, equipment, access, cooperation, coordination and services to allow the testing of concrete and concrete reinforcement to be carried out by a Testing Agency responsible to the Owner.
- .2 The scope of the required quality assurance testing is described in this section to inform the Contractor of the type and scope of testing on the project and to allow the Contractor to make appropriate allowances. The costs for the testing described in this section is not the responsibility of the Contractor. It will be paid for by the Owner. It is the responsibility of the Contractor to schedule the testing described, to coordinate construction schedules with the Testing Agency, and to cooperate with the Testing Agency in the execution of this work.
- .3 The scope of the required quality assurance testing is described in this section to inform the Contractor of the type and scope of testing on the project and allow the Contractor to make appropriate allowances.
- .4 Testing required by the Contractor for his own quality control will be paid for by the Contractor.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 03200 - Concrete Reinforcement
- .2 Section 03300 - Cast-in-Place Concrete

1.4 REFERENCE STANDARDS

- .1 Testing of concrete and reinforcement shall conform to the requirements of the following Standards unless otherwise required by this specification:
 - .1 National Building Code of Canada - 2015.
 - .2 CSA-A23.1-04 - Concrete Materials and Methods of Concrete Construction.
 - .3 CSA-A23.2-04 - Methods of Test and Standard Practices for Concrete.
- .2 Where the Standard is referenced in this specification it shall mean the documents specified in this clause, and their referenced Standards.
- .3 A copy of A23.1 and A23.2 shall be kept on site by the Contractor for the duration of the work and be made available for reference.

1.5 DEFINITIONS - FOR THIS SECTION

- .1 "Owner", "Contractor", "Departmental Representative", as per the General Conditions and Definitions.
- .2 "Specialty Engineer" is a Professional Engineer registered in B.C. responsible for components designed by the Contractor and who seals and signs shop drawings.
- .3 "Testing Agency" shall mean the testing agency responsible to the Owner.

- .4 “Standard” and “Standards” shall mean the reference standards listed under “Reference Standards” in this section.

1.6 APPOINTMENT OF TESTING AGENCY

- .1 The Owner shall hire a CSA-approved Testing Agency who shall test concrete, reinforcement and grout as per this specification.
- .2 Testing paid for by the Owner.
 - .1 Review of initial mix designs.
 - .2 Testing as outlined in Section 3.0, except for testing required by the Contractor for stripping of formwork.
- .3 Testing paid for by the Contractor.
 - .1 Review of Contractor-requested mix design changes.
 - .2 Any waiting time incurred by the Testing Agency in excess of 1/2 an hour.
 - .3 Any additional costs due to overtime, shift work, holiday or weekend work, except that the Owner will pay for holiday or weekend pickup when the concrete was placed on a regular workday.
 - .4 Costs for testing required by the Contractor for stripping of formwork, such as field cure cylinders etc.
 - .5 Cost for retesting or additional testing of concrete or reinforcement where tests have failed to meet the specified requirements.

Part 2 Duties

2.1 RESPONSIBILITY OF THE CONTRACTOR

- .1 The Contractor shall cooperate fully with the Testing Agency.
- .2 The Contractor shall give the Testing Agency at least four (4) hours prior notice of concrete placement.
- .3 It is the Contractor's responsibility to provide a finished product that meets the specification. If initial tests indicate that the concrete failed to meet the specification, the Departmental Representative shall decide if any additional testing is necessary. This testing shall be done by a CSA-approved Testing Agency, but need not be the Owner's agency. The proposed additional testing shall have prior approval of the Departmental Representatives.
- .4 Strengths of cored samples must equal the specified strength if tested dry or 85% of specified if tested wet, with wet or dry tests as per the Standard.

1.2 RESPONSIBILITY AND DUTIES OF THE TESTING AGENCY

- .1 The Testing Agency is responsible to the Owner and has the authority to, and is expected to, reject any concrete not meeting the specifications.
- .2 If the Testing Agency becomes aware that concrete is being placed without their notification, or if insufficient notice is received, then the Testing Agency shall notify the Departmental Representative immediately.
- .3 Low 7-day, 28-day, and 56-day strength tests shall be brought immediately to the attention of the Departmental Representative and the Contractor.

Part 3 Testing - Concrete And Reinforcement**3.1 GENERAL**

- .1 All strength tests shall be numbered consecutively and the cylinders marked as follows:
 - .1 7-Day Test: Marked "A".
 - .2 28-Day Test: Two (2) cylinders marked "B" and "C".
- .2 All tests reports shall record:
 - .1 Name of Project
 - .2 Date and time of sampling
 - .3 Name of supplier
 - .4 Delivery truck number
 - .5 Batch time and discharge time
 - .6 Identification of sampling and testing technicians
 - .7 Exact location in the structure of the concrete sampled
 - .8 Design strength of concrete sampled
 - .9 Admixtures, cement type, maximum aggregate size
 - .10 Air and concrete temperature
 - .11 Slump, and air content
- .3 All field cured cylinders shall be marked "F".
- .4 Slump tests shall be performed prior to the addition of superplasticizers.
- .5 Tests for slump and air content shall be taken with each strength test and as required by the specifications and drawings.

3.2 REGULAR TESTING - CONCRETE

- .1 To conform to the Standard, except each test shall consist of three (3) cylinders - one (1) for 7-day strength and two (2) for 28-day strength.

3.3 FIELD CURED CYLINDERS

- .1 Field cure cylinders shall be protected against wind and be stored on the floor immediately below the slab they represent unless the floor below is heated. In that case they shall be stored on top of the slab but covered with a plywood box. The cylinders are to be undisturbed at this location until picked up by the Testing Agency. Field core cylinders are not to be stored in temperature controlled containers.

3.5 TESTING REINFORCEMENT

- .1 The Testing Agency shall, over the duration of the project, perform at least one (1) tensile and bend test for each bar size and mill stamp used on the project. Such testing shall comply with the applicable CSA documents. Further testing may be requested at the Departmental Representative's discretion.
- .2 The Testing Agency will select the bars to be tested from the reinforcing supplied to the construction site, not from the suppliers' yard. The Contractor shall cut the

bars to the required length and replace the shortened bars without cost to the Owner.

- .3 The Contractor shall supply mill certificates of chemical analysis in accordance with CAN/CSA G30.18R and G30.18W for all bar supplied to site.

END OF SECTION 03050

Part 1 General**1.1 DOCUMENTS**

- .1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 DESCRIPTION OF WORK INCLUDED

- .1 Provide all labour, materials, equipment and services necessary to supply, erect, and strip all formwork and falsework for poured-in-place concrete shown or indicated on the contract drawings and specifications.
- .2 Install all anchor bolts, embedded metal, inserts, hangers, reglets, dovetail anchors etc. supplied by applicable trades for casting into concrete and assume responsibility for correct positioning within the agreed tolerance and in accordance to drawings supplied by the trade.
- .3 Install all openings, sleeves, blockouts, etc. required by other trades and assume responsibility for correct positioning within the agreed tolerance and in accordance to drawings supplied by the trade.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 032000 - Concrete Reinforcement
- .2 Section 033000 - Structural Cast-in-Place Concrete
- .3 Section 033125 – Architectural Concrete

1.4 REFERENCE STANDARDS

- .1 Concrete formwork shall conform to the requirements of the following Building Code:
 - .1 National Building Code of Canada – 2015
- .2 Concrete formwork shall conform to the requirements of the following Standards unless otherwise required by this specification:
 - .1 CSA-A23.1 - Concrete Materials and Methods of Concrete Construction.
 - .2 CSA-A23.2 – Methods of Test and Standard Practices for Concrete.
 - .3 CSA-A23.3 - Design of Concrete Structures.
 - .4 CSA-S269.1 – Falsework and Formwork
 - .5 CSA-S269.3 – Concrete Formwork
 - .6 Workers' Compensation Board of B.C. (WCB) – Sections 20.17 to 20.26.
- .3 The revision date of all referenced codes, standards, and guidelines shall be as indicated in the above referenced Building Code. Where no reference is made within the Building Code, the latest published edition shall be used.
- .4 Where the Standard is referenced in this specification, it shall mean the documents specified in this clause and their referenced documents.
- .5 A copy of A23.1 and A23.2 shall be kept by the Contractor on site for the duration of the work and be made available for reference.

- .6 Where there are differences between the specifications and drawings and the codes, standards or acts, the most stringent shall govern.

1.5 DEFINITIONS - FOR THIS SECTION

- .1 “Owner”, “Contractor”, “Departmental Representative” as per the General Conditions and Definitions.
- .2 “Specialty Engineer” is a Professional Engineer registered in B.C. responsible for components designed by the Contractor and who seals and signs shop drawings.
- .3 “Standard” and “Standards” shall mean the reference standards listed under “Reference Standards” in this section.

1.6 SUBMITTALS

- .1 Shop Drawings for Formwork, Falsework, and Reshoring
 - .1 The structural drawings shall not be reproduced, in whole or in part, for use as shop drawings.
 - .2 Well in advance of construction, submit to the Departmental Representative drawings showing the complete design of the slab formwork, falsework, and reshoring systems stamped by a qualified Professional Engineer licensed in the Province of BC.
- .5 As a minimum, show the following:
 - .1 Stripping schedule;
 - .2 Sequence for installing reshores;
 - .3 Number of slabs reshored at any given time;
 - .4 Formwork details related to stripping and reshoring;
 - .5 Locations of proposed construction joints; and
 - .6 Camber.
- .6 When requested, submit a written proposal for review by the Departmental Representative as to how the specified cambers are to be achieved, in the field.
- .7 Opening information
 - .1 Submit drawings of the structure showing formed holes, recesses and sleeving required under all Sections.
- .8 As-Built Drawings
 - .1 Mark on a complete set of final reproducible drawings any changes, additions or deletions that occur during construction as a result of the Contractor’s work, change orders, or for any other reason.
- .9 Sloping Roofs or Floors
 - .1 When requested, well in advance of construction, submit complete details of forming together with placing and compaction procedures for sloping roofs or floors, including details of construction and placing of top forms and top form panels.

Part 2 Products

2.1 GENERAL

- .1 Products shall satisfy the requirements of the Standard unless otherwise specified herein or on the drawings.

2.2 MATERIALS

- .1 Form Material
 - .1 Exposed surfaces - High density overlay form ply (Ainsworth 107 or preapproved equal), metal, plywood or plywood lined. Plywood to conform to the Standard.
 - .2 Unexposed surfaces - metal, plywood, or wood lumber to conform to the Standard.
 - .3 Plywood and wood formwork materials shall, conform to the Standard, be free from warp and sawn straight so that lines and shapes will be accurately retained.
 - .4 Un-lined forms for unexposed surfaces shall be made with a good grade of lumber or plywood and fitted so that there will be no leakage of mortar.
 - .5 Use metal forms, plywood lined forms or plywood forms of sufficient structural strength for exposed surfaces. Plywood for lining shall be GIS exterior grade fir plywood with waterproof glue.
 - .6 Proprietary and/or modular forming systems shall be designed such that they do not interfere with the specified placement of reinforcement or other embedded hardware and must be pre-approved by the Departmental Representative.
- .2 Ties And Spreaders
 - .1 Use metal form ties that are adjustable in length to permit tightening of forms. Use only the snap-off type of form ties which will permit no metal within 25mm (1") of the concrete surface after removal. Twisted wire form ties will not be accepted.
 - .2 Wood spreaders inside wall forms will not be permitted.
- .3 Form Release Agent
 - .1 Use a non-staining form release agent that is compatible with any finishes/membranes specified elsewhere in the contract documents.

Part 3 Execution

3.1 GENERAL

- .1 All phases of concrete formwork construction shall be in accordance with the Standard unless otherwise specified herein or on the drawings. Only workers who are skilled and experienced in their trade shall do the work.

3.2 CONCRETE WORK AT EXISTING STRUCTURE

- .1 Before proceeding with any work in or adjacent to the existing structure, verify that conditions are as indicated on the drawings. If they are not, notify the

Departmental Representative of discrepancies and do not proceed until the Departmental Representative has given instructions.

- .2 Protect and support existing services that may interfere with underpinning work.

3.3 LINES AND LEVELS

- .1 Verify lines, levels and column centres before proceeding with work and ensure that dimensions agree with drawings.
- .2 Co-ordinate and co-operate with all other trades in forming and setting of recesses, chases, sleeves, inserts, bolts, and hangers.

3.4 DESIGN OF FORMWORK, FALSEWORK AND RESHORING

- .1 Conform to the Standard.
- .2 Design formwork and reshoring to safely support vertical and lateral loads until they can be supported by the structure. Design formwork for loads and lateral pressures recommended in CSA S269.1. The Contractor shall assume full responsibility for the structural adequacy of the forms to withstand all concrete, environmental, and construction loads.
- .3 Design and provide shoring and bracing to excavations and underpinning to safely withstand any lateral pressures to which they may be subjected.
- .4 See drawings for locations where reinforced concrete members are not structurally stable until walls and slabs intersecting with them have been constructed to the specified level and the concrete has reached at least 70% of the specified strength.
- .5 Design shores for these slabs and walls to safely support the total vertical and lateral loads until the walls and slabs are complete and have reached 70% of their specified strength. Design the shores so that they can be unloaded gradually.
- .6 As a minimum, the work shall conform to the Standard. Refer to "Formwork for special Architectural finishes" in CSA-A23.1 for architectural concrete.
- .7 Where concrete is exposed to view, forms are to be laid out so that joints are kept to a minimum and located in an orderly and symmetrical arrangement wherever possible. Form ties shall be evenly spaced and located in straight horizontal and vertical lines. Spacing and location of form tie holes shall be detailed by the Contractor and approved by the Departmental Representative. See also the architectural drawings and specifications for any special requirements for architectural, or exposed, concrete.
- .8 The strength and rigidity of forms shall be such that they will not leak mortar or result in visible irregularities in the finished concrete. In addition the deflection of facing materials between studs, as well as the deflection of studs and walers, shall not exceed 0.0025 times the span.
- .9 Forms shall be so constructed that the finished concrete will conform to the shape, dimensions and tolerances as specified in the Standard or on the structural drawing, whichever is most rigorous. They shall also incorporate the cambers specified on the structural drawings. Movement resulting from form support deflection, closure of form joints, and elastic shortening of forms and shoring, must be calculated and added to the cambers indicated on the drawings.

- .10 Construct forms so that they may be dismantled and removed without damaging the concrete.
- .11 The Contractor shall submit details of the sequence and extent of formwork removal and re-shoring to the Departmental Representative for review. Such details shall include magnitude of loads and location of all reshores at each level. Forms shall not be removed or adjusted until the review is complete. Such review does not relieve the Contractor of responsibility for formwork and safety during construction.
- .12 Set shores on wedges or use adjustable shores so they may be removed without causing undue strains in the concrete.
- .13 Do not exceed the safe capacity of the structure with any construction or shoring loads. The safe capacity of the structure may be taken as the design live load, as indicated on the structural drawings, multiplied by the ratio of the concrete strength at the time of loading to the specified concrete strength, but not greater than 1.0.

3.5 ERECTION

- .1 Sleeves and openings shown on the structural drawings must be confirmed with mechanical, electrical and architectural drawings. Any discrepancies are to be reported to the Departmental Representative.
- .2 Sleeves and openings not shown on the structural drawings must be approved by the Departmental Representative.
- .3 Keep all untreated forms moist to prevent shrinkage prior to placing of concrete and wet the surface at time of placing.
- .4 Treated formwork surfaces shall have the approved form coating applied in accordance with the manufacturer's recommendations, prior to placing reinforcing steel. Remove any excess form coating. Do not apply form release agent after reinforcing steel has been placed. Ensure reinforcing steel does not come in contact with form release oil.
- .5 Erect, support, brace, and maintain formwork to safely support vertical and lateral loads until they can be supported by the structure.
- .6 All falsework erection shall be supervised by the Professional Engineer responsible for its design.
- .7 All forms shall be inspected by the contractor, prior to the concrete pour to ensure that they have been erected in conformance with the formwork shop drawings.
- .8 Construction
 - .1 Form footing sides unless footings are shown to be placed against undisturbed soil. [or unless excavation is left with vertical sides against which the concrete can be directly cast.]
 - .2 Where shown, camber formwork such that hardened concrete, prior to stripping of forms, is cambered as shown. Maintain beam depth and slab thickness from cambered surface.
 - .3 Camber slabs and beams [1 in 500] of span unless shown otherwise.

- .4 Mark building, grid or other lines on forms to permit the accurate positioning of reinforcing steel.
- .5 Construct templates and supports to rigidly fix reinforcing dowels in the forms prior to concreting.
- .6 Provide suitable markers to indicate the location and configuration of continuing concrete members so that dowels can be positioned accurately in relation to their position in the continuing members.
- .7 Set anchor bolts, templates, steel connection units, hardware, or other inserts into the forms and secure them rigidly so that they do not become displaced during concreting. Set and secure these items to the tolerances specified and required in the appropriate Sections.
- .8 Build top forms on sloping concrete where required to prevent flow of the concrete out of the forms. Provide vents to top forms to permit air or bleed water to escape from the forms.
- .9 Where concrete is poured against structural steel beams causing unbalanced horizontal pressures, provide sufficient horizontal support to resist such pressures and to prevent deflection of the steel beams.
- .10 Where foundations are poured directly into fresh rock excavations place compressible foam around foundations unless excavations are left open for more than 100 days prior to pouring.

3.6 TOLERANCES

- .1 The tolerances for all concrete work shall conform to the requirements of the Standard and Drawings.
- .2 Variations in building lines which result in extension of the building over lot lines or restriction lines will not be permitted.
- .3 These tolerances are acceptable with regard to structural requirements. Interfacing tolerances may not be compatible with the above. Review and coordinate interfacing tolerances so that the various elements come together properly.

3.7 PRODUCT HANDLING

- .1 Protect formwork materials before, during and after installation and protect installed work and materials of other trades.
- .2 In the event of damage, immediately make required repairs or replacements necessary to the approval of the Departmental Representative at no extra cost to the Owners.

3.8 REMOVAL OF FORMWORK

- .1 Forms shall not be removed until concrete has attained sufficient strength that no damage to strength or continuity of concrete will occur when forms are removed. Time for formwork removal of suspended concrete shall be approved by the Departmental Representative. See also the requirements of Section 3.3.
- .2 Prying against face of concrete to remove forms is not allowed, only wooden wedges shall be used.
- .3 Removal of form ties shall be done carefully to avoid marking concrete and to

allow for patching. Grout bottom of form tie hole to prevent rust staining.

- .4 As a minimum conform to requirements of CSA S269.3 and the following:
 - .1 Design of reshore shall accommodate load distribution resulting from differences in stiffness between storeys such as slabs, transfer floors, and grade.
 - .2 Do not strip within one and a half bays of a construction joint until new concrete beyond the construction joint has reached 75% of its specified 28 day strength.
 - .3 Provide and install adequate shoring to safely support horizontal or inclined members after the 28 day specified strength is achieved where superimposed loads exceed design loads.
 - .4 Side forms for vertical members may be stripped as soon as the concrete is sufficiently strong to stand unsupported and safely resist imposed loads.

3.9 DELAY STRIPS

- .1 Maintain bays containing delay strips and each adjacent bay fully formed and shored until the strip is complete, and has reached its 28 day specified strength. Ensure that the forms and shores are designed so that no settlement of the forms occur during the period that the strip is open.

END OF SECTION 03 11 00

Part 1 General**1.1 DOCUMENTS**

- .1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 DESCRIPTION OF WORK INCLUDED

- .1 Provide all labour, materials, equipment and services necessary to supply and install reinforcing steel work shown or indicated in all the contract drawings and specifications including accessories such as hanger bars, spirals, wire ties, support bars, chairs, spacers supports or other devices required to position reinforcing properly.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 03050 - Testing of Concrete and Reinforcement
- .2 Section 03300 - Cast-in-Place Concrete
- .3 Section 05100 - Structural Steel (** **Confirm Section**)

1.4 REFERENCE STANDARDS

- .1 Concrete reinforcing shall conform to the requirements of the following Standards unless otherwise required by this specification:
 - .1 National Building Code of Canada - 2015.
 - .2 CSA-A23.1-04 - Concrete Materials and Methods of Concrete Construction.
 - .3 CSA-A23.2-04 - Methods of Test and Standard Practices for Concrete.
 - .4 CSA-A23.3-04 - Code for the Design of Concrete Structures for Buildings.
 - .5 CAN/CSA G30.18 - Billet Steel Bars for Concrete Reinforcement
 - .6 CSA-W47.1 - Certification Of Companies For Fusion Welding Of Steel Structures
- .2 Where the Standard is referenced in this specification it shall mean the documents specified in this clause and their referenced documents.
- .3 A copy of A23.1 and A23.2 shall be kept by the Contractor on site for the duration of the work and be made available for reference.

1.5 DEFINITIONS FOR THIS SECTION

- .1 "Owner", "Contractor", "Departmental Representative" as per the General Conditions and Definitions.
- .2 "Specialty Engineer" is a Professional Engineer registered in B.C. responsible for components designed by the Contractor and who seals and signs shop drawings.
- .3 "Standard" and "Standards" shall mean the reference standards listed under "Reference Standards" in this section.

1.6 TESTING

- .1 As per Section 03050 - Testing of Concrete and Reinforcement.

1.7 Part 2 Products**2.1 GENERAL**

- .1 Products shall satisfy the requirements of the Standard unless otherwise specified herein or on the drawings.

2.1 MATERIALS

- .1 Reinforcing bars shall conform to the Standard unless otherwise specified herein or on the drawings.
- .2 Reinforcing bars to be welded shall conform to the Standard, G30.18W.

Part 3 Execution**3.1 GENERAL**

- .1 All phases of concrete reinforcement work shall be in accordance with the Standards unless otherwise specified herein or on the drawings. The Contractor shall ensure that the work is executed only by workers skilled and experienced in their trade.
- .2 The Contractor shall notify the Departmental Representative at least 24 hours before any concrete is placed in order that the Departmental Representative may review the work.

3.2 SHOP DRAWINGS

- .1 Submit shop drawings for concrete reinforcement, bar support and accessories for review by the Departmental Representative at least 14 days prior to the placement of rebar.
- .2 Clearly indicate bar sizes, grades, spacing, location and quantities of reinforcing mesh, bar supports and accessories and identifying code marks to permit correct placement without reference to structural drawings.
- .3 Placing drawings and bar lists will be reviewed for number and size of bars only and this review shall in no way relieve the Contractor of his responsibility for carrying out the Work in accordance with the drawings.
- .4 Substitution of imperial reinforcing sizes and grades will only be accepted if placing drawings showing imperial sizes are submitted to the Departmental Representative for review. Approval must be obtained before any work is commenced.

3.3 FABRICATION

- .1 Fabricate all reinforcing to the Standard and contract documents.
- .2 Reinforcing bars shall be cold bent. Bars shall not be straightened or re-bent.
- .3 Splices in reinforcing bars at locations not shown on the drawings must be submitted for review by the Departmental Representative. Such splices shall conform to the Standards.
- .4 Colour code each bar to correspond with code mark appearing on bar list.

3.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- .1 Store reinforcement in a manner to prevent excessive rusting and fouling with

dirt, grease, form-oil and other bond-breaking coatings

- .2 Reinforcement at the time concrete is placed shall be free from excessive rusting, mud, oil or other coatings that adversely affect its bonding capacity

3.5 PLACING

- .1 Reinforcing of size and shapes shown on the structural drawings shall be accurately placed in accordance with the drawings and the requirements of the Standard.
- .2 Reinforcement shall be adequately supported by chairs, spacers, support bars, hangers or other accessories, and secured against displacement within the tolerances permitted in the Standard. Support devices contacting surfaces exposed to the exterior shall be non-corroding.
- .3 Bars that are not part of the structural design or drawings, and whose only function is supporting other reinforcing in lieu of other support accessories, shall be considered as accessories.
- .4 All rebar shall be adequately tied and chaired to maintain it in the specified location during pouring. Lifting of reinforcing or welded wire mesh into specified position during the concrete pour will not be allowed.
- .5 Tolerances for bar placement shall be as per the Standard. Tolerances shall not be used to justify the use of chair, bolsters, or chair/support combinations which result in improper cover.

3.6 WELDING

- .1 Any welding of reinforcing steel shall be in accordance with the Standard.
- .2 Welding of concrete reinforcement shall be performed by workmen who are approved by the Canadian Welding Bureau in accordance with the Standard. Copies of the Canadian Welding Bureau approved welding procedure and certificate of current operator qualification shall be submitted to the Departmental Representative prior to commencement of welding.

3.7 CONSTRUCTION REVIEW

- .1 No concrete shall be placed until the Departmental Representative has completed a review of reinforcing in place. The Contractor shall provide a minimum of 24 hours notice of the time when the reinforcement will be substantially in place and ready for the Departmental Representatives review. A minimum of 6 hours is to be provided for review and any required remedial work prior to concrete placement.

END OF SECTION 03200

Part 1 General**1.1 DOCUMENTS**

- .1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 DESCRIPTION OF WORK INCLUDED

- .1 Provide all labour, materials, equipment and services necessary to supply and install cast-in-place concrete work shown or indicated in all the contract drawings and specifications including concrete toppings, bases, sumps, curbs, posts, manholes, pits, paving, sidewalks, equipment bases or curbs, grouting of baseplates, etc.
- .2 Coordinate concrete placement fully with other trades. Ensure other related work such as inserts, dowels, sleeves, reinforcement, etc. is complete before placing concrete.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 03050 - Testing of Concrete and Reinforcement
- .2 Section 03200 - Concrete Reinforcement
- .3 Section 03345 - Special Concrete Finishes (** Confirm Section)
- .4 Section 05100 - Structural Steel

1.4 REFERENCE STANDARDS

- .1 Concrete work shall conform to the requirements of the following Building Codes and Referenced Standards unless otherwise required by this specification:
 - .1 Building Code
 - .1 National Building Code of Canada - 2015.
 - .2 Referenced Standards
 - .1 CSA-A23.1 - Concrete Materials and Methods of Concrete Construction.
 - .2 CSA-A23.2 - Methods of Test for Concrete.
 - .3 CSA-A23.3 - Code for the Design of Concrete Structures for Buildings.
 - .4 CSA-S413 - Parking Structures.
- .1 Where the Standard is referenced in this specification it shall mean the documents specified in Clause 1.4.1.2, as specified in the Building Code noted in Clause 1.4.1.1, and their referenced Standards.
- .2 A copy of A23.1 and A23.2 shall be kept by the Contractor on site for the duration of the work and be made available for reference.

1.5 DEFINITIONS FOR THIS SECTION

- .1 "Owner", "Contractor", "Departmental Representative" as per the General Conditions and Definitions.
- .2 "Specialty Engineer" is a Professional Engineer registered in B.C. responsible for components designed by the Contractor and who seals and signs shop drawings.
- .3 "Standard" and "Standards" shall mean the reference standards listed under

“Reference Standards” in this section.

1.6 SUBMITTALS

- .1 Keep a record at the job site showing time and place of each pour of concrete, together with a transit-mix delivery slip certifying contents of pour. Make the record available to the Owner for his inspection upon request. Upon completion of this portion of work, submit placing records and delivery slips to the Owner.
- .2 Submit details of proposed methods of concrete curing and provisions for weather protection to the Departmental Representative for review
- .3 Submit plan locations and details of construction joints for the Departmental Representatives review

Part 2 Products

2.1 GENERAL

- .1 Products shall satisfy the requirements of the Standard unless otherwise specified herein or on the drawings.
- .2 Provide samples of materials on request

2.2 MATERIALS

- .1 Cement for S-1, S-2, and S-3 concrete shall be as per Table 3 A23.1 and conform to the Standard.
- .2 Mixing water shall conform to the Standard.
- .3 Air entraining admixtures to the Standard.
- .4 Pozzolan admixtures may be used and shall conform to the Standard.
- .5 Calcium chloride, either as a raw material or as a constituent in other admixtures, shall not be used unless approved in writing by the Departmental Representative.
- .6 Curing compounds shall conform to the specification and shall also be compatible with specified floor hardeners, covering adhesives and waterproofing compounds.
- .7 Grout shall be preapproved, premixed, non-shrink conforming to the Standard. Exposed grout shall be non-staining cement grey in colour.

Part 3 Execution

3.1 GENERAL

- .1 All phases of concrete work shall be in accordance with the Standard unless otherwise specified herein or on the drawings. The work shall be executed only by experienced and skilled workers.
- .2 The Contractor shall notify the Departmental Representative at least 30 hours before any concrete is placed to allow the Departmental Representative to review the work.

3.2 MIX DESIGNS

- .1 Concrete mixes shall be proportioned by the supplier to meet the compressive strength, exposure class, and other performance specifications noted in the contract documents. In addition, concrete mix design shall satisfy the transport, placing, and finishing requirements of the Contractor. All concrete shall be normal weight unless noted otherwise. Concrete types are specified in accordance with CSA-A23.1 Table 5, Alternate 1.

- .2 Concrete mix design is the responsibility of the supplier, including the use of admixtures, alone or in combination. The supplier is also responsible for ensuring the plastic and hardened properties of the concrete meet the construction and specified requirements. This includes the long term performance of the hardened mix.
- .3 Pump mix slumps shall also conform to the above.
- .4 Water/Cement ratios and air contents for exposure class shall be as per the Standard.
- .5 The proposed mixes shall be submitted to the Departmental Representative and Testing Agency for review.
- .6 The mix designs shall note the constituents by weight, the properties required by the structural drawings, and the structural elements for which the mix is to be used.

3.3 PRODUCTION

- .1 Production shall conform to the Standard.

3.4 TESTING

- .1 As per Section 03050 - Testing of Concrete and Reinforcement

3.5 PLACING OF CONCRETE

- .1 Conveying and placing of concrete is to conform to the Standard.
- .2 All concrete shall be consolidated by means of vibrators of appropriate size operated by experienced workers.
- .3 The use of vibrators to transport concrete shall not be permitted.
- .4 Cement slurry used to prime concrete pumps shall be discarded and not placed in the project.

3.7 OPENINGS AND INSERTS

- .1 The Contractor shall notify all trades sufficiently in advance to ensure that provision is made for openings, inserts and fasteners. The Contractor shall cooperate with all trades in the forming and setting of all slots, sleeves, bolts, dowels, hangers, inserts, conduits, clips, etc. Any embedded hardware may be subject to review by the Departmental Representative.
- .2 Openings and sleeves shown on the structural drawings must be confirmed with mechanical, electrical and architectural drawings.
- .3 Openings and sleeves not shown on the structural drawings must be approved by the Departmental Representative.

3.8 CONSTRUCTION AND CONTROL JOINTS

- .1 Construction joints shall conform to the Standard except that for horizontal joints in walls it will be sufficient to place fresh concrete on a clean rough surface unless directed otherwise by the Departmental Representative or otherwise noted on the structural drawings.
- .2 Joints in slabs on grade shall be located as indicated on the structural and/or architectural drawings. Unless noted otherwise on the drawings a joint in the slab on grade may be a pour joint, trowelled joint, saw cut, or other pre-approved method. The depth of joints shall be a minimum of $\frac{1}{4}$ of the thickness of the slab. Saw cut joints are to be completed within 24 hr. of placing. Alternative joint

details are to be submitted in writing to the Departmental Representative.

- .3 For vertical joints in walls below grade, see standard detail on structural drawings. For locations, see architectural and structural drawings.
- .4 Construction joints in walls and columns shall occur at the top of slab and at the underside of slab/beam systems unless noted otherwise on the structural drawings.
- .5 Construction joints not shown in the drawings or specifications shall be subject to the approval of the Departmental Representative. The Departmental Representative may require keys, or extra reinforcing to be provided at the Departmental Representative's discretion with associated costs borne by the Contractor.
- .6 The existing concrete surface at construction joints shall be wetted thoroughly immediately prior to placement of concrete.
- .7 Construction joints exposed to view may be subject to non-structural review by Departmental Representative.
- .8 Unless noted otherwise on the drawings, control joints in walls are to be located at a maximum spacing of 9m (30') on centre and detailed as indicated on the structural drawings.

3.9 CURING AND PROTECTION

- .1 Curing procedures shall be in accordance with the Standard. Alternate methods with Departmental Representatives approval, may be used providing they produce concrete that meets the contract documents.
- .2 Cold and hot weather protection shall comply with the Standard or the requirements on the structural drawings, whichever are more rigorous.
- .3 Concrete place during extreme drying conditions shall satisfy clause 7.4.2.2 of A23.1.

3.10 PATCHING

- .1 Honeycomb, exposed reinforcement and other defects shall be repaired and patched by the Contractor at the Contractor's cost using a procedure preapproved by the Departmental Representative. Exposed patching must also be approved by the Departmental Representative.
- .2 Immediately after the removal of forms, all bolts, ties, nails or other metal not specifically required for construction purposes shall be removed or cut back to a depth of 25 mm (1") from the surface of the concrete.

3.11 TOLERANCES

- .1 Tolerances shall conform to the Standard or the requirements on the structural or architectural contract documents, whichever are more rigorous.

3.12 FINISHING - FLOORS

- .1 Finishing shall conform to CSA-A23.1 - Section 7.5 as a minimum. Care shall be taken during finishing to maintain the cambers specified on the structural drawings. See also the architectural drawings and specifications for additional finish requirements.
- .2 Unless noted otherwise, floor finishes shall be Class A "institutional and commercial floors" and have gaps less than or equal to 8.0 mm (5/16") under a 3000 mm (10'-0") straight edge. Only a single curvature within this distance is

allowed.

3.13 FINISHES - FORMED SURFACES

- .1 All formed surfaces shall be treated in accordance with CSA A23.1, Section 7.7 as a minimum. See also architectural drawings and specifications for additional finish requirements.

3.14 ARCHITECTURAL CONCRETE

- .1 All exposed concrete elements are classified as “Architecturally Exposed” concrete. See architectural drawings and specifications for any requirements. Conform to CSA-A23.1 - Section 8.3 as a minimum.

3.15 OPENINGS THROUGH STRUCTURAL WORK

- .1 If, after any part of the structural work has been completed, it is required that additional openings be made through the structure, the Departmental Representative shall be so informed. No opening, including cored sleeves, shall be made through completed work without authorization in writing from the Departmental Representative.

3.16 REJECTION OF DEFECTIVE WORK

- .1 In the event that concrete tests do not conform to the requirements of this specification, or when conditions are such to cause doubt about the safety of the structure, testing of the structure will be undertaken at the direction of the Departmental Representative. This may entail further concrete tests, coring or load testing as per the Standard, or any other test the Departmental Representative deems suitable. Such test shall be made at the expense of the Contractor and to the satisfaction of the Departmental Representative.
- .2 Where, in the opinion of the Departmental Representative, material or workmanship fails to meet the requirements of the specification, such work may be rejected. Work rejected shall be replaced or repaired to the approval of the Departmental Representative and at no additional cost to the Owner.

End of Section 03300

Part 1 General**1.1 DOCUMENTS**

- .1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 DESCRIPTION OF WORK INCLUDED

- .1 This section includes requirements regarding the appearance and surface preparation of Architecturally Exposed Concrete (AEC). Refer to Sections 031100 Concrete Forming and Accessories and 033000 Structural Cast-In-Place Concrete for all other requirements regarding concrete work not included in this section. This section applies to any members noted on Architectural [and Structural] drawings as AEC.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 030050 - Testing of Concrete and Reinforcement
- .2 Section 031100 - Concrete Forming and Accessories
- .3 Section 033000 – Structural Cast-in-Place Concrete
- .4 Section 032000 - Concrete Reinforcement
- .5 Section 033500 - Concrete Finishing
- .6 Section 051200 - Structural Steel Framing

1.4 REFERENCE STANDARDS

- .1 Concrete work shall conform to the requirements of the following Standards unless otherwise required by this specification:
 - .1 National Building Code
 - .2 CSA-A23.1-09 (R2014) - Concrete Materials and Methods of Concrete Construction.
 - .3 CSA-A23.2-09 (R2014) - Methods of Test for Concrete.
 - .4 CSA-A23.3-14 - Code for the Design of Concrete Structures for Buildings.
 - .5 CSA-S413 - Parking Structures.
 - .6 CSA A3001 - Cementitious Materials for use in Concrete.
 - .7 ACI 347 - Guide to Formwork for Concrete.
 - .8 CSA-S269.3-92 (R2013) – Concrete Formwork
 - .9 Workers' Compensation Board of B.C. (WCB) – Sections 20.17 to 20.26.
(Delete Outside BC)**
- .2 Where the Standard is referenced in this specification it shall mean the documents specified in this clause and their referenced documents.
- .3 A copy of A23.1 and A23.2 shall be kept by the Contractor on site for the duration of the work and be made available for reference.
- .4 Where there are differences between the specifications and drawings and the

codes, standards or acts, the most stringent shall govern.

1.5 DEFINITIONS FOR THIS SECTION

- .1 “Owner”, “Contractor”, “Departmental Representative” as per the General Conditions and Definitions.
- .2 “Specialty Engineer” is a Professional Engineer registered in B.C. responsible for components designed by the Contractor and who seals and signs shop drawings.
- .3 “Standard” and “Standards” shall mean the reference standards listed under “Reference Standards” in this section.

1.6 SUBMITTALS

- .1 When requested, supply samples of all materials to be used in architectural concrete. Supply schedule of architectural concrete work.
- .2 Mix Designs:
 - .1 Mix designs for the Architectural Concrete shall match the color and surface quality defined by the architectural specifications. The acceptance of the concrete color will be decided based on the mock-up field sample.
- .3 When requested, supply samples of all materials and the following, the cost of which shall be paid for by this trade.
 - .1 Two pieces 1 m (3'-0") square of the plywood specified for smooth architectural concrete.
 - .2 Form tie and corner tie.
 - .3 Sample of form joint sealer and caulking to be used in form construction.
 - .4 1 m (3'-0") section of Sonotube form and liner fitted with a column capital form and reglet.

1.7 QUALITY ASSURANCE

- .1 Mock-Up Field Samples:
 - .1 Well in advance of the start of the work; construct mock-up field samples as described below and as specified by the Architect. Mock-up field samples should be constructed for each type of architectural concrete as specified in CSA A23.1, Section 8.3.3. The general purpose of building the mock-up field sample is to establish a process of constructing a successful sample; thus establishing all necessary steps, defining the used materials, mixes and construction techniques and the necessary coordination between the disciplines that make a successful product.
 - .2 Do not cast concrete until written permission has been given by the Departmental Representative.
 - .3 The mock-up field samples shall incorporate concrete of the approved mixes. Use techniques of concrete placing, consolidation curing and sandblasting concrete as will be employed on finished work. The simulator shall have as a minimum the standard of quality specified. If the simulator or parts thereof do not meet this standard, construct additional member or parts thereof at no cost to the Owner until the quality is acceptable to the Departmental Representative. The quality of the accepted mock-up field samples along with the criteria set out below shall be the minimum

acceptable standard for the building.

- .4 The purpose of constructing the simulator is to provide minimum standards by which to judge the finished work, and to provide the Contractor with the opportunity of testing and improving, techniques so that these may be perfected for use on the finished work.
- .5 Note that after approval of the mix, and acceptance of the mock-up field samples, alternative aggregates and source of cement supply will not be permitted.
- .6 In addition to constructing the simulator, employ placing techniques which will be used for architectural concrete as necessary on members which are not to be architecturally exposed so as to perfect technique.
- .7 Note that if the requirements of the mock-up field samples can be successfully incorporated into the building structure in an area not exposed to view a separate mock-up field samples will not be required to be architecturally exposed so as to perfect technique.
- .8 At the conclusion of the work, remove and dispose of the mock-up field samples.
- .9 If the sample panels do not meet the minimum standards specified it may be necessary to construct additional samples. The quality of the approved samples along with the criteria specified shall be the minimum standards for architectural concrete.

Part 2 PRODUCTS

- .1 Refer to Section 031100 Concrete Forming and Accessories and Section 033000 Structural Cast-In-Place Concrete.

Part 3 EXECUTION

- .1 As a minimum, the work shall conform to CSA-A23.1, Section 8.3 for architectural concrete. See also architectural drawings and specifications for any requirements.
- .2 Quality of finish shall be such that concrete is completely free of defects, honeycombing, and other inconsistencies without requiring finishing work. Patching is not permitted and repairs may only be carried out if approved by the Departmental Representative.
- .3 Concrete should be generally even in colour, straight, and have sharp definition at corners and reglets.
- .4 Dense, even concrete, free of major defects such as deep or extreme honeycombing, inconsistencies in plane, severe cold joint lines and major loss of fines. Minor imperfections may be acceptable. Major defects will necessitate replacement. The judgment as to what constitutes major or minor defects will be RJC's alone. Patching is not permitted and if used will constitute a major defect. Repairs, i.e. removal of sections of a member, may be carried out if approved by RJC, but the repair shall match the colour and texture of the surrounding concrete.
- .5 Concrete members with sharp, accurate definition at corners, arises and reglets generally free of chipped or spalled areas and within dimensional tolerances set out in CSA A23.1 and CSA A23.2. Members shall be visually straight.
- .6 Construct forms for architectural concrete so that they are grout tight at corners,

- panel joints, construction joints, arises and recesses and so that concrete surfaces that are shown to be plane are plane and correctly aligned without indentations, ridges, bulges or protuberances other than those shown.
- .7 Make joints of forms sufficiently tight to prevent leakage of concrete fines at corners of exposed beams, walls and columns or at the corners of exposed edges of slabs, and other concrete exposed to view in the finished building.
- .8 Provide 25 mm (1") chamfer strips at all exposed edges of concrete and 18 mm (3/4") v-joints at control joints.
- .9 Under no circumstances shall repair to any architectural concrete be undertaken without RJC's written consent. Concrete members which are repaired without RJC's consent will be classified as defective Work and RJC may require their removal and replacement.
- .10 Curing:
- .11 Provide extra curing to Architectural Concrete to avoid surface cracking. Curing shall be in accordance with A23.1 C1.7.4 and specifically C1.7.4.2.2.1, Curing Type 3 given in Table 20 of the Standard. Ultimately the curing method could be established based on the results achieved on the sample mock-up.
- .12 Formwork material (including lumber, seals, joint backings, form ties) to be to the satisfaction of the Architect.
- .13 All panel arrangements, patterns, recesses, protuberances and joints to be to the satisfaction of the Architect.
- .14 Tie pattern to be to the Architect's approval.
- .15 Where re-use of forms is permitted, arrange so that tie holes are also re-used. All form ties, particularly at corners and construction joints, shall be fully tightened so as to eliminate leakage of concrete fines.
- .16 Forms for duct openings, sills and the like shall be removable to permit access for concrete placing and vibration.
- .17 Braces or shores through exposed faces of walls will not be permitted.
- .18 Coordinate with other trades and provide protection to slab forms as required to prevent damage or staining during the work of other trades.
- .19 Construction joints will be permitted only at the locations shown, or where not shown, only at locations approved by the Architect.
- .20 Forms for architectural concrete shall not be stripped until at least 7 days after concrete is poured. Take particular care when stripping to ensure that no damage occurs at corners, arises or the like.
- .21 To help avoid colour variation, the length of time between pouring and stripping shall be approximately the same for each portion of the Work.
- .22 Thoroughly clean forms and treat with the parting agent as required before re-use. Forms may not be re-used if they are damaged in any way which will leave blemishes on the finished surface. Also, they may not be re-used if the original tie holes are not re-used.
- .23 Placing of Concrete:

- .1 Before concrete is placed, thoroughly clean forms, re tighten as is necessary and saturate the surface of construction joints and form sides with water.
- .2 In walls or columns, except where these are to be sandblasted, begin the pour by depositing in the bottom of the form a 75 mm (3") layer of cement sand mortar of the same mix as the concrete used for the work, except that the coarse aggregate is omitted. Pour concrete immediately after the grout is poured.
- .3 The maximum free drop of concrete shall not exceed 1.3 m (4' 0").
- .4 Deposit concrete in as close to its final position as possible and do not allow to flow laterally more than 0.6 m (2').
- .5 For depositing concrete in walls provide suitably sized tapered pouring boxed to funnel the concrete into the forms. Provide sufficient boxes for each pour such that they can be placed simultaneously at approximately 2 m (6' 0") on centres for the entire length of the pour.
- .6 To compact concrete use internal vibrators 25 mm (1") to 50 mm (2") in diameter as required. Apply vibrators at sufficiently short intervals that vibrated areas overlap without omission of any part. Ensure that the vibrators are inserted through the layer being compacted but take care not to damage form sheathing. Leave vibrator in place from 5 to 15 seconds and withdraw slowly leaving the vibrator operating.
- .7 Arrange operations so that once a pour is started, concreting is carried on continuously and the concrete at the surface of the pour is maintained plastic until the completion of section.
- .8 Shortly after concrete is placed and compacted to the top of walls or columns or to the top of construction joints, rework the concrete with wooden chisels at the exposed faces to a depth of at least .6 m (2') and then re vibrate.
- .9 At the correct time provide a fine wood float surface to tops of walls, balustrades, retaining walls and the like. Remove laitance as necessary before finishing the concrete. After stripping, lightly rub corners with an emery stone to eliminate sharp edges.
- .10 Trowel the surface of construction joints adjacent to exposed faces, flush and level. Joints in walls shall be made at the top of any reglet unless shown otherwise.
- .23 Protection:
 - .1 At all times during the work protect architectural members as required with polyethylene sheets or the like from staining or becoming coated with leakage, due to continuing concreting operations. Protect concrete from staining due to rusting of reinforcing steel
- .24 Treatment of Formed Surfaces:
 - .1 After forms are stripped go over the surface carefully, removing loose concrete, lumber in reglets, minor fins and the like, leaving the surface clean. After the surfaces are cleaned the Departmental Representative will make an examination of them to determine their acceptability. If

unacceptable, the Contractor shall remove the members and replace them at no extra cost to the Owner.

- .2 As previously noted, patching will only be permitted where it is required to an insignificant extent. If the Departmental Representative permits patching, demonstrate to the Departmental Representative's satisfaction that the patch will accurately match the colour and texture of the surrounding concrete and will have satisfactory tenacity

.25 Sandblasting:

- .1 Do not proceed with sandblasting operations until the Departmental Representative has inspected and approved the surface to be sandblasted.
- .2 Protect adjacent surfaces not noted to be sandblasted.
- .3 Fill form tie holes prior to sandblasting. Add high strength cement to the grout as necessary so that it will match the parent concrete strength.
- .4 Sandblast surfaces within 28 days after concreting.
- .5 Individual concrete members shall be sandblasted at the same age to ensure reasonable colour uniformity.
- .6 Maintain reglet filler strips in place until sandblasting is complete.
- .7 Sandblast the exposed surface of concrete members as required to a depth sufficient to remove the surface skin and to just expose the coarse aggregate and to match the approved sample.
- .8 Medium sandblast the exposed surface of concrete members to a depth sufficient to remove the surface skin and to just expose the coarse aggregate and in any event to at least a depth of 4.5 mm (3/16")

.26 Bush Hammering:

- .1 Do not proceed with bush hammering operation until the Departmental Representative has inspected and approved the surface to be bush hammered.
- .2 Fill form tie holes at least [7] days prior to bush hammering.
- .3 Bush hammer surfaces to a penetration of approximately 5 mm with a single point chisel on a pneumatic hammer or by other approved means to produce a chipped, roughened surface. The number of penetrations shall be such that none of the original smooth formed surface remains. Hose down the bush hammered surface to remove loose materials. Carry out bush hammering so that the work is uniform in all respects.
- .4 Bush hammering may be carried out at any time between 7 and 30 days, depending upon construction convenience, although it shall be carried out between 7 and 10 days if reasonably possible to do so.
- .5 Each significant area shall be bush hammered at the same age in order to ensure reasonable colour uniformity. Carry out bush hammering operations so that resulting surfaces are uniform in texture and colour. Protect adjacent surfaces not noted to be bush hammered

.27 Filling Form Tie Holes:

- .1 On surfaces exposed to view seal the form tie holes with Mills Grout Plugs

- in accordance with manufacturer's instructions.
- .2 Fill the 40 mm (1 ½") depth of the form tie hole with a grout containing an approved bonding agent which matches the parent concrete, except that the coarse aggregate shall be omitted and the proper amount of white cement and/or limestone screenings shall be used to adjust the colour of grout to match the parent concrete when cured.
 - .3 When consistency of the grout shall be such as to be slightly damp to the touch (just short of "balling"), hammer the grout back from the surface of the surrounding concrete approximately 10 mm (3/8"). Leave the surface of the grout plug smooth and ensure that any excess grout is removed from the surface of surrounding concrete.
 - .4 On surfaces exposed to view, where ties are to be exposed or accentuated, fill form tie holes with natural colour plastic, set back plugs such as type [RSP manufactured by Richmond Screw Anchor Company, Toronto], or approved equal in accordance with the manufacturer's instructions.
 - .5 On surfaces exposed to view, but where ties are to be concealed, fill the 40 mm (1 ½") depth of form tie holes to within 6 mm (¼") of the surface with an approved polysulphide caulking compound which matches the colour of the concrete.
 - .6 Seal form tie holes with plastic, set back plug in accordance with the manufacturer's instructions.
 - .7 On surfaces exposed to view, fill the 40 mm (1 ½") depth of form tie holes with an approved polysulphide caulking compound which matches the colour of the concrete.
- .28 Cleaning Surfaces:
- .1 As late as possible prior to turning the building over to the Owner, clean down concrete to remove surface discolourations, efflorescence and the like. Use a suitable cleaning agent which will not itself stain the surfaces or mar the texture through chemical reaction.
 - .1 Do not apply curing compounds of any type on concrete surfaces to receive Roofing System. Moist curing only will be permitted.
 - .2 Slightly round with a mason's stone all exterior corners of concrete roofs prior to application of roofing.
- .29 Under no circumstances shall repair to any architectural concrete be undertaken without RJC's written consent. Concrete members which are repaired without RJC's consent will be classified as defective and RJC may require their removal and replacement.

3.1 ADDITIONAL REQUIREMENTS FOR ARCHITECTURAL CONCRETE

- .1 Strictly maintain bar clearances for architectural concrete. Place spacers regularly and squarely against forms except that spacers shall not be used between reinforcement and an exposed vertical concrete face.
- .2 The location of spacers shall not cause constriction adjacent to other inserts which may impede the placing of concrete.

- .3 The cover to reinforcement shall be taken from the deepest penetration of arises or reglets.
- .4 Use spacers and support accessories so that no metal comes closer than 40 mm ($1\frac{5}{8}$ ") to an exposed surface.
- .5 Ensure that no tie wires project within 40 mm ($1\frac{5}{8}$ ") of an exposed face.
- .6 Take particular care not to damage form sheathing surfaces during installation of reinforcement.
- .7 Increase cover to reinforcement as specified on drawings.

END OF SECTION 03 31 25

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 03 30 00 - Cast-in-Place Concrete.

1.2 REFERENCES

- .1 American Concrete Institute (ACI):
 - .1 ACI 117-10 (R2015), ACI Manual of Practice: Specifications for Tolerances for Concrete Construction and Materials, (ACI 117-10) and Commentary.
 - .2 ACI 301-16, Specification for Structural Concrete.
 - .3 ACI 302.1R-15, ACI Manual of Practice: Guide for Floor and Slab Construction.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM D1751-04(2013)e1, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
 - .2 ASTM D1752-04a(2013), Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-25.20-95, Surface Sealer for Floors.
- .4 Canadian Standards Association (CSA)
 - .1 CSA-A23.1- 05/A23.2-14, Concrete Materials and Methods of Concrete Construction/Testing Methods and Standard Practices for Concrete, Includes Update No. 1 (2015).
- .5 International Concrete Repair Institute (ICRI)
 - .1 ICRI 310.2R-2013, Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings and Polymer Overlays and Concrete Repair – Guide Only
- .6 South Coast Air Quality Management District (SCAQMD), California State
 - .1 SCAQMD Rule 1113-16, Architectural Coatings.

1.3 PERFORMANCE REQUIREMENTS

- .1 Product quality and quality of work in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Submit written declaration that components used are compatible and will not adversely affect finished flooring products and their installation adhesives.

1.4 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures.
 - .1 Submit manufacturer's printed product literature, specifications and data sheet for each product specified.

- .2 Submit WHMIS MSDS - Material Safety Data Sheets. WHMIS MSDS acceptable to Labour Canada and Health and Welfare Canada for concrete floor treatment materials. Indicate VOC content.
- .3 Include application instructions for concrete floor treatments.
- .2 Submit closeout data in accordance with Section 01 78 00 – Closeout Submittals.
- .1 Provide manufacturer's printed recommendations for general maintenance, including cleaning instructions and submit a complete list of floor care products that will be required for on-going maintenance.

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Waste Management and Disposal.

1.6 ENVIRONMENTAL REQUIREMENTS

- .1 Temporary lighting:
 - .1 Minimum 1200 W light source, placed 2.5 m above floor surface, for each 40 sq m of floor being treated.
- .2 Electrical power:
 - .1 Provide sufficient electrical power to operate equipment normally used during construction.
- .3 Work area:
 - .1 Make the work area water tight protected against rain and detrimental weather conditions.
- .4 Temperature:
 - .1 Maintain ambient temperature of not less than 10 degree C from 7 days before installation to at least 48 hours after completion of work and maintain relative humidity not higher than 40% during same period.
- .5 Moisture:
 - .1 Ensure concrete substrate is within moisture limits prescribed by flooring manufacturer.
- .6 Safety:
 - .1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials.
- .7 Ventilation:
 - .1 Arrange for ventilation system to be operated during installation of concrete floor treatment materials by use of approved portable supply and exhaust fans.
 - .2 Ventilate enclosed spaces in accordance with Section 01 51 00 - Temporary Utilities.
 - .3 Provide continuous ventilation during and after coating application.

Part 2 Products

2.1 PERFORMANCE/DESIGN CRITERIA

- .1 Refer to Structural Drawings for Slab Cambers as these numbers will rule over the items below.
- .2 F3-Finishing: Floors having a straightedge value of ± 5 mm over 3050 mm; similar to CSA A23.1 Class C Slab Finishing.

2.2 LEVELLING MATERIALS

- .1 Underlayment: Cementitious, self levelling, single component, polymer modified underlayment and manufacturer's low VOC recommended primer, for application thicknesses to a minimum feather edge to 13 mm; acceptable materials as follows:
 - .1 CustomTech TechLevel150, Custom Building Products
 - .2 Eucofloor SL160, by Euclid Chemical.
 - .3 Novoplan 2 Plus, MAPEI Inc.
 - .4 Sikafloor Level 125, Sika Canada Ltd.
 - .5 Sure-Flo ST, Gemite.
- .2 Overlayment: Cementitious, self levelling, single component, polymer modified overlayment, for application thicknesses to a minimum of 13 mm to 25 mm; acceptable materials as follows:
 - .1 CustomTech TechLevel150, Custom Building Products
 - .2 Sikafloor Level 25, Sika Canada Ltd.
 - .3 Sure-Flo FT 100, Gemite.
 - .4 Ultraplan 1 Plus, MAPEI Inc.
- .3 Patching and Flash Patching Materials: Cementitious based, polymer modified, fine aggregate, single component, rapid curing, early strength floor patching compounds having high adhesion with manufacturer's recommended primer and surface profile; for application in thicknesses to a minimum of 4 mm to 25 mm, and as follows:
 - .1 Acceptable Materials:
 - .1 GenPatch, Custom Building Products
 - .2 NXT Patch, Laticrete
 - .3 Planitop 18 ES, MAPEI Inc.
 - .4 SD-P, Ardex
 - .5 SikaQuick 1000, Sika
 - .6 Sealtight Meadow-Crete H, W.R. Meadows

2.3 CRACK REPAIR MATERIALS

- .1 Crack repair and filler: two-component, nonshrink, 100% solids, moisture-insensitive, VOC free, and meeting the requirements of ASTM C881.
 - .1 Basis-of-Design:
 - .1 Planibond EBA, MAPEI Canada Inc.

2.4 HARDENERS

- .1 Type: 1, Sodium silicate, permanent penetrating sealer and hardener
 - .1 Liquid applied, water based, chemically reactive.
 - .2 Non-toxic, non-flammable, and anti-dusting have low or no VOC.
 - .3 Colour: colourless
 - .4 Acceptable Materials:
 - .1 Ashford Formula, Curecrete
 - .2 Euco Diamond Hard, Euclid Chemical Company
 - .3 Mapecrete Hard SB, Mapei Inc.
 - .4 Seal Hard, L&M Construction Company
 - .5 Sealtight Liqui-Hard, W.R. Meadows
 - .6 Sikafloor 3S, Sika Canada
- .2 Water: potable.

2.5 SEALING COMPOUNDS

- .1 Surface sealer: to CAN/CGSB-25.20, Type 2 - water based, clear.
 - .1 Surface sealers manufactured or formulated with aromatic solvents, formaldehyde, halogenated solvents, mercury, lead, hexavalent chromium and their compounds are not acceptable.
 - .2 Surface sealer shall be compatible with the hardener and shall be manufactured by hardener manufacturer.
 - .3 Surface sealer shall have less than 100g/l of VOC in accordance with SCAQMD Rule #1113.
- .2 Wax: acrylic caruba wax.

2.6 CURING COMPOUNDS

- .1 Select low VOC, water-based, organic-solvent free curing compounds.
 - .1 Concrete Curing Compounds: maximum VOC limit 100 g/L in accordance with SCAQMD Rule #1113.

2.7 MIXES

- .1 Mixing, ratios and application in accordance with manufacturers instructions.

2.8 ACCESSORIES

- .1 Joint Filler Strips:
 - .1 Floor Isolation Joints: ASTM D1751, bituminous impregnated fibreboard, or ASTM D1752, cork or self-expanding cork, 13 mm thick minimum.
 - .2 Edge Joint Filler: ASTM D1751, bituminous impregnated fibreboard, 13 mm thick minimum.
- .2 Control Joint Filler:
 - .1 Two component, epoxy-urethane, load bearing, self levelling sealant.
 - .1 Acceptable Materials:
 - .1 Euco Qwikjoint UVR, by Euclid Chemical

- .2 Loadflex, Sika Canada
- .3 Planiseal Rapid Joint 15, MAPEI Inc.
- .4 Rezi-Weld Flex, WR Meadows

Part 3 Execution

3.1 EXAMINATION

- .1 Prepare floor surface in accordance with CSA A23.1.
- .2 Verify that slab surfaces are ready to receive work and elevations are as instructed by manufacturer.

3.2 REPAIRS

- .1 Inspect surfaces for defects immediately after removal of forms. Repair or patch defects within 48 hours of removal of forms with cure repairs same as new concrete with Departmental Representatives permission.
- .2 Defective Areas: where patches are allowed, repair and patch areas to match surrounding areas in texture and colour.

3.3 FINISHING FORMED SURFACES

- .1 Requirements listed below apply to normal structural concrete; refer to Section 03 30 00 for additional requirements for formed exposed architectural concrete.
- .2 Unspecified Finish: Provide following finishes as applicable when finish of formed surfaces is not specifically indicated:
 - .1 Unexposed Surfaces:
 - .1 Rough form finish for concrete not exposed to view.
 - .2 Smooth form finish for concrete to receive membrane waterproofing.
 - .2 Exposed Surfaces:
 - .1 Smooth form finish for concrete surfaces exposed to view.
- .3 Rough Form Finish: Leave surfaces with texture imparted by forms; patch tie holes and defects; remove fins longer than 6 mm high.
- .4 Smooth Form Finish: Coordinate as necessary to secure form construction using smooth, hard, uniform surfaces with number of seams kept to a minimum, uniformly spaced in an orderly pattern; patch tie holes and defects; completely remove fins.
- .5 Related Unformed Finish: Strike-off concrete smooth and finish with using texture matching adjacent formed surfaces at tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces; continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces.
- .6 Penetrating Sealer Finish: Apply penetrating sealer to vertical surfaces after any patching, joint sealing or caulking is completed in accordance with manufacturer's written instructions.

3.4 FINISHING FLOORS AND SLABS

- .1 Finish floors and slabs in accordance with CSA A23.1 and ACI 302.1R recommendations for screeding, re-straightening, and finishing operations for concrete surfaces; do not wet concrete surfaces.
- .2 Scratch Finishing:
 - .1 Texture concrete surface that have been screeded and bull-floated or darbied while still plastic.
 - .2 Use stiff brushes, brooms, or rakes to produce a profile amplitude of 6 mm in 1 direction.
 - .3 Apply scratch finishing to surfaces indicated and to receive concrete floor toppings
- .3 Float (Initial) Finishing:
 - .1 Consolidate surface with power driven floats or by hand floating if area is small or inaccessible to power driven floats.
 - .2 Re-straighten, cut down high spots, and fill low spots.
 - .3 Repeat float passes and re-straightening until surface is left with a uniform, smooth, granular texture.
 - .4 Apply float finishing to surfaces indicated and receiving fluid applied sheet.
- .4 Trowel (Final) Finishing:
 - .1 Commence trowel finishing after all bleed water has disappeared and when the concrete has stiffened sufficiently to prevent the working of excess mortar to the surface.
 - .2 Apply first trowelling and consolidate concrete by hand or power-driven trowel after applying float finishing; continue trowelling passes and re-straighten until surface is free of trowel marks and uniform in texture and appearance; repair or smooth any surface defects that would telegraph through applied coatings or floor covering.
 - .3 Apply a trowel finishing to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system] [Insert locations].
 - .4 Finish surfaces to the tolerances indicated above.
- .5 Trowel and Fine Broom Finishing:
 - .1 Apply trowel finishing to surfaces indicated
 - .2 Slightly scarify surface with a fine broom While concrete is still plastic.
 - .3 Finish surfaces to the tolerances indicated above.
- .6 Sandblast Finishing:
 - .1 Use abrasive grit, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces to provide levels of finish as follows:
 - .1 Light Blast Finish: Exposes some of the fine aggregate as well as removing surface dirt and stains; depth of cut shall not exceed 1.5 mm.

- .2 Medium Blast Finish: Exposes the top faces of the coarse aggregate faces near the surface; depth of cut shall not exceed 5 mm.

3.5 APPLICATION: GENERAL

- .1 After floor treatment is dry, seal control joints and joints at junction with vertical surfaces with sealant.
- .2 Apply floor treatment in accordance with Sealer manufacturer's written instructions.
- .3 Clean overspray. Clean sealant from adjacent surfaces.
- .4 Cure concrete in accordance with manufacturers recommended procedures.

3.6 APPLICATION: LIQUID APPLIED FLOOR HARDENER

- .1 Apply liquid floor hardener in accordance with manufacturer's written instructions after initial floating.
- .2 Cure concrete in accordance with manufacturer's recommended instructions.
- .3 Apply hardener to horizontal and vertical exposed concrete to remain unfinished.

3.7 PROTECTION

- .1 Protect finished installation in accordance with manufacturer's instructions.

3.8 MAINTENANCE

- .1 Provide training to Owners representative based on written manufacturers instructions as indicated in Section 01 78 00 – Closeout Submittals.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 05 50 00 – Metal Fabrications
- .2 Section 06 10 00 – Rough Carpentry
- .3 Section 07 27 19 – Sheet Membrane Air and Vapour Barrier
- .4 Section 08 11 16 – Aluminum Doors and Frames

1.2 REFERENCES

- .1 American Society for Testing of Materials (ASTM)
 - .1 ASTM C97/C97M-15, Standard Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone.
 - .2 ASTM C99/C99M-15, Standard Test Method for Modulus of Rupture of Dimension Stone.
 - .3 ASTM C119-16, Standard Terminology Relating to Dimension Stone.
 - .4 ASTM C170/C170M-16, Standard Test Method for Compressive Strength of Dimension Stone.
 - .5 ASTM C207-06(2011), Standard Specification for Hydrated Lime for Masonry Purposes.
 - .6 ASTM C568/C568M-15, Standard Specification for Limestone Dimension Stone.
 - .7 ASTM C847-14a, Specification for Metal Lath.
 - .8 ASTM C933-14, Standard Specification for Welded Wire Lath.
- .2 Canadian Standards Association (CSA)
 - .1 CSA A179-14, Mortar and Grout for Unit Masonry, Includes Update No. 1 (2006), Update No.2 (R2011).
 - .2 CSA A370-14, Connectors for Masonry
 - .3 CSA A371-14, Masonry Construction for Buildings.
 - .4 CSA-A3000-13, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005), Includes Update No. 1 (2014), Update No. 2 (2014).

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Convene pre-installation meeting one week prior to beginning work of this Section, with Contractor, Departmental Representative, installer, manufacturer's representative to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.

1.4 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittals:

- .1 Submit manufacturer's printed product literature, specifications and datasheet.
- .2 Submit test reports covering conformance of stone to ASTM Standards.
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittals:
 - .1 Submit complete cutting and setting drawings for all stone work. Show in detail the sizes, sections and dimensions of stone, the arrangement of joints and bonding, anchoring and other necessary details. Indicate an identifying number or mark for each stone. Clearly indicate anchoring, dowelling, and cramping of stone work and detail all connections to the structure.
- .3 Submit samples in accordance with Section 01 33 00 – Submittals:
 - .1 Submit 3 stone veneer units showing the range of colour possible within each type specified.
- .4 Submit laboratory test reports certifying compliance of mortar ingredients with specification requirements.

1.5 QUALITY ASSURANCE

- .1 Installer Qualifications: Engage experienced installer who has completed systems similar in material, design, and extent to that indicated for Project and with record of successful performance and is approved by manufacturer.
- .2 Fabricate stone, detail and fabricate supports, and do masonry work in accordance with CSA A371 except where specified otherwise.
- .3 Do masonry reinforcing and tying in accordance with CSA A370 unless specified otherwise.
- .4 Make and use mortar in accordance with CSA A179 unless specified otherwise.

1.6 MOCK-UPS

- .1 Construct mock-up in accordance with Section 01 45 00 – Quality Control.
- .2 Construct a portion of one exterior wall in location agreed upon by Departmental Representative to establish a standard of construction, workmanship, and appearance.
- .3 Do not continue with work of this Section until Departmental Representative has reviewed mock-up. When accepted, mock-up will demonstrate minimum standard or quality required for work of this Section.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

- .1 Deliver materials to job site in dry condition.
- .2 Keep materials dry until use.
- .3 Store materials under waterproof cover on pallets or plank platforms held off ground.

1.8 ADVERSE WEATHER REQUIREMENTS

- .1 In cold weather conform to Clause 5.15.2 of CSA A371 and maintain temperature of mortar between 5 degrees C and 50 degrees C until used.

- .2 In hot weather protect freshly laid masonry from drying too rapidly, by means of waterproof, non-staining coverings.

1.9 PROTECTION

- .1 Keep masonry dry using coverings that extend over walls and down sides sufficiently to protect walls from wind driven rain, until masonry work is completed and protected by flashings or other permanent construction.
- .2 Protect masonry and other work from marking and other damage. Protect completed work from mortar droppings. Use non-staining coverings.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturers: Subject to compliance with requirements specified in this section and as established by the Basis-of-Design materials, manufacturers offering similar products that may be incorporated into the Work include the following:
 - .1 Boral Stone
 - .2 Cultured Stone
 - .3 Eldorado Stone
 - .4 K2 Stone

2.2 PERFORMANCE/DESIGN CRITERIA

- .1 General: Design, fabricate and install stonework to withstand normal loads from wind, gravity, movement of building structure, and thermally induced movement, as well as to resist deterioration under conditions of normal use including exposure to weather.

2.3 STONE MATERIALS

- .1 Stone:
 - .1 Colour and Texture: as indicated on Drawings.
- .2 Provide corner units, caps and other accessories for a complete and finished installation. Accessories to match stone wall material.

2.4 ACCESSORIES

- .1 Building Paper: Asphalt impregnated kraft paper manufactured from virgin cellulose and having a 30 minute moisture resistance rating meeting the requirements of CGSB 51.32.
- .2 Metal Lath: Minimum 2.5 lb (3.4 lb for open stud construction) galvanized expanded metal lath (Diamond mesh) in accordance with ASTM C847
- .3 Sealants: Refer to Section 07 92 00.
- .4 Sealer: Silane based sealer, breathable type as recommended by Manufacturer.
- .5 Mortar: Type S and as follows:
 - .1 Cement: complying with ASTM C270.
 - .2 Lime: ASTM C207.

- .3 Sand: ASTM C144, natural or manufactured sand.
- .4 Color Pigment: ASTM C979, mineral oxide pigments.
- .5 Water: Potable.
- .6 Pre-Packaged Latex-Portland Cement Mortar: ANSI A118.4.
- .6 Fasteners: Galvanized nails, screws or as approved by stone work manufacturer.
- .7 Flashing: as indicated in Section 07 62 00 – Sheet Metal Flashing and Trim.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify conditions of substrate previously installed are acceptable for stone installation in accordance with stone suppliers written instructions.
 - .1 Visually inspect substrate with Departmental Representative present.
 - .2 Inform Departmental Representative of unacceptable conditions upon discovery.
 - .3 Proceed with installation after unacceptable conditions have been remedied.

3.2 INSTALLATION

- .1 Lay Work true to line and level. Accurately space courses, keep bond plumb throughout. Corners and reveals shall be plumb and true. Check Work regularly.
- .2 Do not shift or tap units after mortar has taken initial set. If adjustment is required, remove mortar and use fresh mortar.
- .3 Where fresh stonework abuts or is built upon partially or fully set stonework, clean the exposed surface and dampen to obtain bond.
- .4 Use no toothing of new Work into Work that has set unless approved by Departmental Representative; rake back one-half unit lengths where a stop-off is necessary.
- .5 Open stonework pallets and work from a number of pallets, to mix units; before laying to ensure that an even, consistent colour/texture range is provided without obvious or unsightly colour changes.

3.3 INSTALLATION OF STONE

- .1 Refer to manufacturers written instructions for installation procedures and Drawings for details for manufactured veneer as indicated on Drawings.
- .2 Over sheathing and layers of 30-minute building paper (air barrier), mechanically fasten galvanized expanded metal lath on centres recommended by Manufacturer. Ensure lath is overlapped 406 mm at corners and at no point left butted together.
- .3 Over lath (applied so “the cups” are pointing upwards) apply scratch coat.
- .4 Mix mortar to a firm, moist consistency. Take precautions during dry, hot weather, or during near freezing conditions. Do not re-temper mortar that has passed initial set.
- .5 Upon completion of scratch coat, tool or groove surface providing for mechanical bond of subsequent stone and mortar. Allow scratch coat to cure.

- .6 To cured scratch coat apply mortar and stone according to manufacturers written instruction, starting from the corners and moving to the centre of any given panel.

3.4 CONCEALED WORK

- .1 All head and bed joints in concealed work are to be mortar filled and compacted with the point of the trowel or rodded.
- .2 Compacted joints are required for improved air and sound sealing.

3.5 CUTTING AND FITTING

- .1 Build in chases, piping, ducts, sleeves, grounds, blocking, inserts, supports, conduit, outlet boxes, recessed fittings, fixtures and access panels as required to complete the Work. Cooperate fully to ensure correct size, shape and location.
- .2 Cut and make good the stonework to accommodate other Work as the Work proceeds.
- .3 Fill all openings or voids left for services, etc. Where exposed, use same material as remainder of wall; elsewhere use brick or other suitable bearing masonry. Neatly cut to exposed contours of the space, using full size units where possible.
- .4 Obtain Departmental Representative's approval before cutting any part or area that may impair appearance or strength.
- .5 Exposed chases requiring patching are not permitted without approval.

3.6 BUILT-IN WORK

- .1 Set loose and miscellaneous items of steel and iron into stonework.
- .2 Fill pressed steel frames in stonework openings with mortar or grout.

3.7 JOINTS FOR SEALANT

- .1 Form concave recessed joints where sealed joints are required.
- .2 Form recessed joints where stonework abuts concrete in exposed locations and where indicated.

3.8 CONTROL JOINTS

- .1 Where a control joint is indicated on the architectural drawings, form a continuous vertical joint in the facing, free of mortar. If none are indicated, contact Departmental Representative for verification of locations.
- .2 Form joints to same width as regular jointing, but not exceeding 13 mm unless otherwise indicated.
- .3 Locate joints at 6000 mm centres maximum and at a maximum of 4000 mm from any corners, any other indication notwithstanding.
- .4 Refer to elevations on Drawings for locations.

3.9 STONEWORK CLEANING

- .1 At completion, brush and clean exposed stonework using clean water.
- .2 Comply with manufacturer's cleaning recommendations. Do not use cleaning compounds, additives, soaps or detergents unless approved in writing by both the stonework manufacturer and the Departmental Representative.

- .3 Use of acids is not allowed.
- .4 Clean the stonework work using methods approved by the manufacturer.
- .5 Do not use wire brushes or metal tools for cleaning - use fibre brushes, nylon brushes or wood paddles.
- .6 Do not wipe-off mortar or grout runs while wet. Wait until dry and then remove.

3.10 SEALING

- .1 Seal stone work in accordance with manufacturers written instruction.

END OF SECTION

Part 1 General**1.1 DOCUMENTS**

- .1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
- .2 Drawings include architectural, mechanical, and electrical drawings.

1.2 DESCRIPTION OF WORK INCLUDED

- .1 Provide all labour, materials, equipment, access, cooperation, coordination and services to allow the testing of structural steel, open web steel joists, structural steel deck and welds to be carried out by a Testing Agency responsible to the Owner.
- .2 The scope of the required quality assurance testing is described in this section to inform the Contractor of the type and scope of testing on the project and allow the Contractor to make appropriate allowances. The testing describe in this section is not the responsibility of the Contractor. It will be paid for by the Owner.
- .3 Testing required by the Contractor for his own quality control will be paid for by the Contractor.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 051200 - Structural Steel Framing.

1.4 REFERENCE STANDARDS

- .1 Testing of Structural Steel shall conform to the requirements of the following Building Code and Reference Standards unless otherwise required by the specification:
 - .1 Building Code
 - .1 National Building Code of Canada – 2015
 - .2 Reference Standards
 - .1 CSA S16 - Limits States Design of Steel Structures.
 - .2 CSA S136 - North American Specification for the Design of Cold-Formed Steel Structural Members
 - .3 CSA W47.1 - Certification of Companies for Fusion Welding of Steel Structures.
 - .4 CSA W59 - Welded Steel Construction (Metal Arc Welding).
 - .5 CSA W178.1 - Certification of Welding Inspection Organizations.
 - .6 CSA G40.20 - General Requirements for Rolled or Welded Structural Quality Steel.
 - .7 CSA G40.21 - Structural Quality Steel.
 - .8 ASTM A123 - Zinc (Hot-Dip Galvanizing) Coatings on Iron and Steel Products.
 - .9 ASTM A143 - Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.

- .10 ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - .11 ASTM A384 - Safeguarding Against Warpage and Distortion During Hot Dip Galvanizing of Steel Assemblies.
 - .12 ASTM A780-01 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings.
- .2 Where the Standard is referenced in this specification it shall mean the documents specified in clause 1.4.1.2, as specified in the Building Code noted in clause 1.4.1.1, and their referenced documents.

1.5 DEFINITIONS FOR THIS SECTION

- .1 “Owner”, “Contractor” and “Departmental Representative” as per the General Conditions and Definitions.
- .2 “Structural Engineer” shall mean a representative of Read Jones Christoffersen Ltd.
- .3 “Testing Agency” shall mean the testing agency responsible to the Owner.
- .4 “Non-destructive Testing” shall mean magnetic particle, ultrasonic, or radiographic testing as determined appropriate by the Testing Agency.
- .5 “Standard” and “Standards” shall mean the reference standards listed under “Reference Standards” in this section.

1.6 APPOINTMENT OF TESTING AGENCY

- .1 The Owner will appoint a Testing Agency approved under W178.1 (Building Category).
- .2 Testing paid for by the Owner is outlined in Section 3.0.
- .3 Testing paid for by the Contractor.
 - .1 Testing of pre-approved connections not on the structural drawings and required by the Contractor for ease of fabrication, transportation or erection.
 - .2 Any additional costs due to overtime, shift work, holiday or weekend work required to meet the schedule.
 - .3 Costs for retesting or additional testing due to work having failed to meet the specified requirements.
 - .4 For the purpose of bidding, assume all welds will be examined by a nondestructive testing method. Non-destructive testing will be performed on samples of the work at the discretion of the Structural Engineer as well as outlined in this specification. Any repair and retesting costs shall be borne by the Contractor.

Part 2 Duties

2.1 RESPONSIBILITY OF THE CONTRACTOR

- .1 The Contractor shall cooperate fully with the Testing Agency. Allow free access to all parts of the work for the purpose of testing and review at all times.
- .2 Notify the Testing Agency and Structural Engineer when work is ready for review.
- .3 Prior to commencement of work, provide a schedule of shop fabrication and erection to the Testing Agency and Structural Engineer.

- .4 Provide mill certificates in accordance with the Standard, properly correlated to the elements being fabricated.
- .5 The Contractor is solely responsible to provide a finished product that meets the specifications and contract documents. Testing is not carried out for the Contractor's benefit, nor does it make the Structural Engineer or Testing Agency guarantors of the Contractor's work.

2.2 RESPONSIBILITY AND DUTIES OF THE TESTING AGENCY

- .1 The Testing Agency is responsible to the Owner and has the authority to, and is expected to, reject any work not meeting the specifications.
- .2 Review the structural drawings and specifications prior to carrying out the work.
- .3 Provide testing as per the Standards and as per this specification.
- .4 Provide timely test reports to the Structural Engineer, Departmental Representative and Contractor.
- .5 Provide a signed letter at the completion of the project to the Owner, with copies to the Departmental Representatives and Contractor. The letter shall confirm that testing has been carried out as per the specifications. The letter shall also confirm all deficiencies found by the Testing Agency have been resolved.

Part 3 Testing – Structural Steel

3.1 GENERAL

- .1 The Structural Engineer may reject at any time during the progress of the work a piece of material or any member which the Structural Engineer may find defective or not in accordance with the detailed drawings. This material may be rejected notwithstanding any previous acceptance and components so rejected shall be replaced at no expense to the Owner. In case of dispute, the decision of the Structural Engineer shall be final
- .2 Testing in general shall conform to CSA S16 and W59. Acceptance criteria for welding to be for statically loaded structures as per W59.
- .3 If initial tests indicate that the work failed to meet specification, the Structural Engineer shall decide if any additional testing is necessary. This testing shall be done by the Owner's agency. The proposed additional testing shall have prior approval of the Structural Engineer.
- .4 Confirm that the fabricator and erector are certified to CSA-W47.1 and that all welders are properly qualified.
- .5 Review welding procedures.
- .6 Confirm welding consumables are properly stored in shop and field.
- .7 Review mill certificates for the material used and forward to the Structural Engineer.
- .8 Non-destructive testing operators to have Level II qualifications as a minimum.

3.2 TESTING OF STRUCTURAL STEEL

- .1 Randomly check and record structural steel member sizes - 5% to 10%.
- .2 Check grade markings on structural steel in fabricator's plant prior to fabrication.
- .3 Provide a visual review of 100% of all types of welds and 100% of workmanship.

- .4 Randomly select shop welds for nondestructive testing - 5% to 10% of connections.
- .5 Randomly select field welds for nondestructive testing - 5% to 10% of connections.
- .6 Review all snug tight bolted connections to determine that plates are in contact. Check 10% ± of bolts for snugness, including anchor bolts.

3.3 TESTING OF HEADED STUDS AND DEFORMED BAR ANCHORS

- .1 Visually inspect 100% of welds.
- .2 Reinforcing bars butt-welded to plates shall be tested as per this section, and shall be weldable grade (W) reinforcing.
- .3 1%± of randomly selected studs will be tested by bending to an angle of 30%. Minimum of four (4) studs to be tested. Studs on composite beams shall be bent towards the nearest column.
- .4 0.33% (1 in 300)± of randomly selected studs will be tested to destruction. Minimum of four (4) studs to be tested.
- .5 Failure of the weld of any studs will be cause for rejection of the stud welding and cause for further testing at the Structural Engineer's discretion and at the Contractor's expense.
- .6 A 10% or greater failure rate at the welds of the tested studs will be cause for rejection of all studs.
- .7 Studs tested to destruction shall be replaced by the Contractor and retested.
- .8 Replacement of failed or rejected studs shall be at the Contractor's expense.
- .9 Shop welded studs may be fillet welded. Field applied studs shall be applied using the manufacturer's stud gun and procedures or shall be rejected

END OF SECTION 050050

Part 1 General**1.1 DOCUMENTS**

- .1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
- .2 Drawings include architectural, mechanical, and electrical drawings.

1.2 DESCRIPTION OF WORK INCLUDED

- .1 Provide all labour, materials, equipment and services to supply, design, and erect structural steel required and/or indicated on the drawings or specified herein, including the supply of plates and/or angles for support of masonry, embedded steel parts, headed stud and deformed bar anchors, wedge anchors, and epoxy anchors which will form the connection between the structural steel, open web steel joists and masonry or concrete; and reinforcement of steel deck openings larger than 400 mm (16"). Report any discrepancies between structural, mechanical, electrical and architectural drawings to the Departmental Representative and Structural Engineer immediately.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- .1 Section 033100 – Structural Cast-in-Place Concrete
- .2 Section 050050 - Testing of Structural Steel, Open Web Steel Joists and Deck

1.4 REFERENCE STANDARDS

- .1 Structural steel shall conform to the requirements of the following Standards unless otherwise required by the specification:
 - .1 Building Code
 - .1 National Building Code of Canada – 2015
 - .2 Reference Standards
 - .1 CSA S16 - Limits States Design of Steel Structures.
 - .2 CSA S136 - North American Specification for the Design of Cold-Formed Steel Structural Members
 - .3 CSA W47.1 - Certification of Companies for Fusion Welding of Steel Structures.
 - .4 CSA W59 - Welded Steel Construction (Metal Arc Welding) (Metric version).
 - .5 CSA G40.20 - General Requirements for Rolled or Welded Structural Quality Steel.
 - .6 CSA G40.21 - Structural Quality Steel.
 - .7 CSA G30.18 - Billet Steel Bars for Concrete Reinforcement.
 - .8 CSA W186 - Welding of Reinforcing Bars in Reinforced Concrete Construction.
 - .9 ASTM F1554 Standard Specification for 36, 55 and 105 ksi yield strength Steel Anchor Bolts.
 - .10 ASTM A193 – Standard Specification for Alloy-Steel Bolting Materials for Special Purpose Applications.

- .11 ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated 120 / 105 ksi Minimum Tensile Strength.
 - .12 ASTM A490 - Standard Specification for Structural Bolts, Alloy Steel, Heat Treated 150 ksi Minimum Tensile Strength.
 - .13 ASTM A496 - Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
 - .14 CISC / CPMA Standard 1-73a - A Quick-Drying One-Coat Paint for Use on Structural Steel.
 - .15 SSPC SP-6 - Commercial Blast Cleaning
 - .16 ASTM A123 - Zinc (Hot-Dip Galvanizing) Coatings on Iron and Steel Products.
 - .17 ASTM A143 - Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
 - .18 ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - .19 ASTM A384 - Safeguarding Against Warpage and Distortion During Hot Dip Galvanizing of Steel Assemblies.
 - .20 ASTM A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings.
- .2 Where the Standard is referenced in this specification it shall mean the documents specified in clause 1.4.1.2, as specified in the Building Code noted in clause 1.4.1.1, and their referenced documents.

1.5 DEFINITIONS FOR THIS SECTION

- .1 "Owner", "Contractor" and "Departmental Representative" as per the General Conditions and Definitions.
- .2 "Structural Engineer" shall mean a representative of Read Jones Christoffersen Ltd.
- .3 "Specialty Structural Engineer" is a Professional Engineer registered in B.C. responsible for components designed by the Contractor and who seals and signs shop drawings.
- .4 "Testing Agency" shall mean the testing agency responsible to the Owner.
- .5 "Standard" and "Standards" shall mean the reference standards listed under "Reference Standards" in this section.

1.6 QUALIFICATIONS

- .1 Structural steel fabricator shall have experience in the fabrication of structural steel.
- .2 Erector shall have experience in the erection of structural steel.
- .3 Steel fabricators and erectors must be certified under requirements of CSA W47.1 as required by CSA S16.
- .4 Welding procedures, welders and welding operations shall be qualified in accordance with Canadian Welding Bureau Standards.

1.7 EXAMINATIONS

- .1 All dimensions shall be taken from the drawings and verified by field measurement. Be responsible for the correctness of such measurements and report to the Departmental Representative and Structural Engineer in writing all discrepancies between measurements in the field and those shown on drawings prior to commencing work. Verify location of anchor bolts and embedded steel and ensure that work prepared by other trades is at a proper elevation, on line, level and true.

1.8 SUBMITTALS

- .1 The Contractor shall submit, before starting work, written evidence of qualification of the steel fabricators and erectors for welding under Canadian Welding Bureau requirements.
- .2 The Contractor shall submit, before starting work written evidence of ability to weld reinforcing steel to structural steel in accordance with CSA W186.
- .3 When requested, submit copies of mill test reports properly correlated to the materials used on the project.
- .4 Provide a schedule of fabrication to the Departmental Representative, Structural Engineer and Testing Agency prior to the commencement of the fabrication.

1.9 SHOP DRAWINGS

- .1 Submit shop drawings prepared under direction of the Specialty Structural Engineer. Drawings of components and connections designed by the Contractor shall be sealed and signed by this Specialty Structural Engineer or a letter shall be submitted at the end of the project signed and sealed by this Specialty Structural Engineer. The letter shall identify what was designed by the Specialty Structural Engineer and list the final shop drawings by number with dates and revision numbers.
- .2 Shop drawings shall show complete shop and erection details necessary for fabrication and erection of the component parts of the structure, including cuts, copes, connections, holes, threaded fasteners, splices and location, type, size and extent of all welds. Splices not shown on the shop drawings will be rejected. All welds, both shop and field, shall be indicated by AWS Welding Symbols as specified in the CSA W59 Appendix D and E.
- .3 Provide a shop drawing clearly locating all anchor bolts, embedded plates, baseplates, etc.
- .4 Provide setting drawings, templates and directions for the installation of anchor bolts, plates and other devices.
- .5 Review of the shop drawings by the Structural Engineer is intended as an assistance to the Contractor and does not relieve the Contractor of his responsibility for the completeness or accuracy of his work and its conformance with the contract documents.
- .6 Fabrication that commences prior to shop drawing review by the Structural Engineer is at the risk of the Contractor.
- .7 Clearly identify on the shop drawing all revisions, changes, or modifications.

- .8 Resubmit reviewed shop drawings where noted in the Read Jones Christoffersen Ltd.'s review stamp, or when the Contractor makes revisions for his own purposes.
- .9 Allow at least two (2) weeks for shop drawing review by the Structural Engineer.
- .10 Structural drawings are not prepared to be used as erection or shop drawings. However, electronic files or sepias may be used by the Contractor under the following conditions:
 - .1 Copyright remains with Read Jones Christoffersen Ltd.
 - .2 The drawings will only be used for shop drawings for this project and not be put to any other use.
 - .3 Read Jones Christoffersen Ltd. assumes no liability for errors or omissions in the drawings. The Contractor assumes all risk and expenses associated with the use of structural drawings in the production of his work.
 - .4 References to Read Jones Christoffersen Ltd. must be deleted from the title block.
 - .5 The Contractor signs a release available from Read Jones Christoffersen Ltd. that addresses the above items in more detail.

1.10 SUPPLY OF ALTERNATE PRODUCTS

- .1 Should the rolled sections shown on the drawings not be procurable, or should substitution for those sections be desired, sections of equivalent strength, may be substituted if approved by the Departmental Representative. In such cases full particulars, thereof must be submitted prior to the closing of Bid. Material substitutions after the closing of Bid, if accepted, will be at the Contractor's cost.

1.11 TESTING AND FIELD REVIEW

- .1 See Section 050050 - Testing of Structural Steel, Steel Joists Framing and Steel Decking.
- .2 The Specialty Structural Engineer responsible for shop drawings, or the Specialty Structural Engineer's representative, shall visit the site to review in place the connections and components designed by that Specialty Structural Engineer. The Specialty Structural Engineer shall be satisfied or take steps to ensure that these connections and components substantially comply with the Specialty Structural Engineer's design. The Specialty Structural Engineer shall then provide a sealed and signed letter to the Departmental Representative and Structural Engineer to this effect.
- .3 Prior to the commencement of work provide a schedule of shop fabrication to the Testing Agency.
- .4 If requested, submit certified mill tests in accordance with the Standards.
- .5 The Contractor shall advise the Testing Agency of the scheduling of all shop and field work pertaining to this Project. The Contractor shall permit the testing agency full access to the fabrication shop and the site, for the purpose of carrying out his work and he shall provide assistance required to aid in the performance of the inspection and testing.

1.12 STORAGE AND HANDLING

- .1 The Contractor shall be responsible for the protection of all steelwork during fabrication, shipping, storage and construction. All small bends and damage shall be reported to the Structural Engineer for instructions. Steel work which is bent, broken or otherwise damaged, shall be repaired or replaced by the Contractor prior to erection to the satisfaction of the Structural Engineer at no cost to the Owner.
- .2 The Contractor shall be responsible for proper scheduling of delivery and erection for the structural steel in accordance with the construction schedule.
- .3 Store structural steel members at the site above ground on platforms, skids or other devices so that ground dampness will not affect the bottom members of the stacks.
- .4 Steel, which is stored outdoors after fabrication, shall be protected from accumulations of standing water.
- .5 Other materials shall be stored in a weather tight and dry place until ready for use in the Work.
- .6 Packaged materials shall be stored in their original unbroken packages or containers.

1.13 COORDINATION WITH OTHER TRADES

- .1 Supply all necessary instructions and drawings to other trades for setting bearing plates, anchor bolts, and other members that are built in with the work of other trades. Provide punched holes for the convenience of other trades in attaching wood blocking or other materials. Coordinate with drawings of other disciplines for locations and details. Supply the necessary material in accordance to the construction schedule.

Part 2 PRODUCTS**2.1 MATERIALS**

- .1 All steel shall be new unless otherwise indicated and be of sizes and shapes listed in the current CISC Handbook or AISC Handbook and as indicated on the drawings.
- .2 Provide only new material (including bolts) manufactured in Canada, United States, United Kingdom or EU country mills. New materials are to be in accordance with the Referenced Standards. New materials are to be traceable and records of mill test certificates are to be provided to the Departmental Representative by the Contractor.
- .3 Where sections identified are not available from Canada, United States, United Kingdom or EU country mills or where the Contractor chooses to use sections produced by other mills, provide new materials of minimum strength and minimum quality noted in the Reference Standard. For Steel that is not produced by Canada, United States, United Kingdom or EU country mills, the Contractor shall make written requests for approval of the alternate mill to the Departmental Representative before proceeding with material procurement. The Departmental Representative reserves the right to require physical test data, in addition to the mill test reports, proving that the steel from the proposed mill meets the specification requirements prior to approving. Steel must conform to the following:

- .1 A total maximum boron content of 0.0008%.
- .2 Each steel batch is to be tested to confirm the steel meets or exceeds the Reference Standards, and does not exceed the maximum boron specified in 2.1.3.1 above.
- .3 Testing of the steel is to be performed in Canada by an ISO 17025 accredited testing laboratory.
- .4 Rolled shapes, except wide flanges, and rolled plate shall be to CSA G40.21 - grade 300W or equal.
- .5 Wide flange rolled shapes and welded wide flange sections shall be to CSA G40.21 - grade 350W or equal.
- .6 Hollow structural sections shall be to CSA G40.21 - grade 350W, Class H or C.
- .7 High strength bolts shall be to ASTM A325 or A490, as required by the drawings.
- .8 Standard anchor rods shall be to ASTM F1554, 36ksi. High strength anchor rods shall be to ASTM A193, grade B7, see drawings for locations, if required.
- .9 Bolts and nuts shall be to ASTM A307.
- .10 Primer for interior exposure not to receive a shop or field paint finish shall be to CISC / CPMA Standard 1-73a or other pre-approved, unless noted otherwise
- .11 Primer used in a multi-coat system where a final shop or field paint finish is to be applied shall conform to the Painting Specification and shall be selected and preapproved by the Architect based on surface preparation, exposure conditions and compatibility with subsequent coatings, unless noted otherwise.
- .12 Brick support angles and related framing materials exposed to weather, shall be galvanized to CSA G164.
- .13 Headed shear stud connectors shall be Nelson anchors with fluxed ends or other pre-approved equal conforming to ASTM A108. Studs to be automatically end welded with suitable stud welding equipment or shop fillet welded to develop full strength of the stud. Field fillet welded studs will be rejected.
- .14 Bar anchors shall be Nelson deformed bar anchors or pre-approved equal conforming to ASTM A496.
- .15 Welding consumables for all processes shall be fully approved by the Canadian Welding Bureau and certified by the manufacturers as complying with the requirements of this specification. Such certificates shall be not more than two (2) years old.
- .16 Electrode strengths to be equal to E49XX (E70XX) or better.
- .17 Grout for column bases shall be non-metallic, non-expanding and non-shrink type with a minimum strength of 35 MPa at 28 days, unless noted otherwise. Grout may be place in a dry pack or flowable consistency

2.2

DESIGN

- .1 Unless otherwise noted connections and trusses shall be designed by the Contractor to the reference Standards by the Specialty Structural Engineer.
- .2 Where connections are detailed, use connection of the type and detail shown on the drawings. Modifications to the specified connection types and details will not be permitted without prior approval from the Structural Engineer.

- .3 The following connections, and any connections so noted on the structural drawings, shall be designed as slip critical and shall be pre-tensioned:
 - .1 Connections where bolts are subject to repeated tensile loads.
 - .2 Connections using slotted holes in the direction of the load or oversize holes unless specifically designed to accommodate movement.
- .4 Connections for wind or seismic lateral load-resisting elements, such as bracing and drag struts, and others so noted on the structural drawings may be designed as bearing connections but shall be pre-tensioned.
- .5 Other bolted connections may be snug tight.
- .6 Use standard connection types where connections are not detailed on the structural drawings.
- .7 Design shall be for the forces and loads shown on the drawings and shall allow for the effects of beam deflections. Provide a minimum of two (2) 19 mm (3/4") A325 bolts or an equivalent weld for all beam to girder and beam to column connections. If forces or loads are not given, the connection shall be designed for the maximum uniform distributed load that the member can carry for the span shown.
- .8 Structural steel members spliced for ease of fabrication or transportation shall have splices designed to develop the full strength and stiffness of the member. Splices shall be subject to non-destructive testing as directed by the Structural Engineer. The cost for such testing shall be borne by the Contractor.
- .9 Provide stiffeners in beam webs at all locations where beams pass over supports. Unless noted otherwise in the structural drawings, web stiffeners shall be 10 mm minimum.
- .10 Provide separators for all double members in accordance with CSA S16.

Part 3 Execution**3.1 FABRICATION**

- .1 Fabrication shall be to CSA S16 and reviewed shop drawings.
- .2 Welding shall be to CSA W59.
- .3 Structural steel work shall be executed by skilled and experienced workmen.
- .4 Fabricated units shall be straight and true and without sharp kinks or bends, accurate to sizes shown.
- .5 Fabricate rolled steel sections so that any camber and/or sweep resulting from manufacturing is positioned to create a hump up between the ends, not a sag down.
- .6 Flame cut steel columns shall have their ends milled. Steel base plates supporting columns shall be flat.
- .7 Unless noted otherwise, all hollow structural sections shall be dry inside and closed airtight with end plates sealed with welds.
- .8 Visually inspect all plates and shapes for laminations. Replace plates or shapes that contain laminations. Repair plates or shapes that contain laminations in a manner approved by the Structural Engineer.

- .9 Headed shear stud connectors and deformed bar anchors shall be applied in strict accordance with the manufacturer's instructions and the Standards or shop fillet welded as per the Standards. Procedural control to be in accordance with W59 as a minimum. Field fillet welds will be rejected.
- .10 Obtain Structural Engineer's approval for holes required through structural steel that are not shown on the drawings.
- .11 Refer to Architectural drawings for extent and location of Architecturally exposed steel elements.
- .12 Remove and replace any work which is not acceptable to the Departmental Representative, when and as directed. Such operation shall not become an extra charge to the Owner.
- .13 Steel members spliced for ease of fabrication shall develop the full strength and stiffness of the member.
- .14 Where roof slopes exceed 5% and do not permit flush bearing of the steel deck on the beams, provide continuous 3mm bent plates to the pitch and necessary to ensure full bearing of the steel deck. Co-ordinate with the deck supplier the locations that will require these bent plates.

3.2 CLEANING AND PRIMING

- .1 All steel shall be thoroughly cleaned of all loose mill scale, loose rust, oil or dirt.
- .2 Architecturally exposed steel members, related framing and exterior steel shall be primed.
- .3 Steel, which will be encased in concrete, fireproofed, zinc coated or galvanized, welded, receive shear studs, faying surfaces of slip resistant connections and the underside of base plates and bearing plates steel shall not be primed.
- .4 Steel girder, beams, trusses, columns, bracing and connections plates on the perimeter of the building shall be primed.
- .5 Other steel for interior exposure shall be primed.
- .6 Structural steel which will not receive a finish paint coat and is required to be primed for interior exposure shall be cleaned in accordance with CISC / CPMA Standard 1-73 (minimum).
- .7 Structural steel to be primed for exterior exposure shall be cleaned in accordance with SSPC SP6 "Commercial Blast Cleaning" as a minimum.
- .8 Structural steel to receive a shop or field paint finish shall be cleaned in accordance with Section 099100 - Painting or SSPC SP6 "Commercial Blast Cleaning", whichever produces a surface which has less rust and mill scale.
- .9 Apply primers in accordance with the manufacturer's instructions.
- .10 Use paint prepared by manufacturer without thinning or adding admixtures. Execute painting on dry surfaces, free from rust, scale, or grease. Do not paint in temperatures lower than 8°C.
- .11 Where finish painting to parts inaccessible for finish painting after final assembly is required, apply two coats of paint during fabrication. Apply paint of 2 different colours so that missed areas can be detected.
- .12 Provide the following touchup for steel in an exterior exposure or which has a finish paint coat. After erection and after connections are completed, provide a

field touchup coat of primer to all surfaces that had no paint shop coat and have been chipped or scraped. Touch up with primer and paint all shop coat painted areas that have been chipped or scraped.

- .13 Provide the following touchup for galvanized steel. After erection and after connections are completed, provide a field touchup coat of zinc rich paint to all surfaces that have been chipped or scraped. After erection and after connections are completed, provide a field touchup coat of zinc metallizing to all surfaces that have been chipped or scraped.

3.3 ERECTION

- .1 The erector is fully responsible for erection methods, equipment, workmanship and safety precautions.
- .2 Confirm the setting of anchor bolts and bearing plates and make an instrument survey to verify the setting prior to erection of steel members.
- .3 Cutting or burning of baseplates to accommodate anchor bolts shall be cause for rejection of baseplates.
- .4 Install all temporary bracing that is required to stabilize the work against wind, earthquake and construction loads. Keep structure true and plumb until completion of the building. Assume complete responsibility for the extent and timing of the removal of such bracing. The bracing members indicated on the drawings are required for the finished structure and shall not be considered as adequate for temporary bracing. Any failure to make proper and adequate provision for stresses occurring during the erection from any causes whatsoever shall be entirely the responsibility of the Contractor.
- .5 As erection progresses, the work shall be securely bolted up to take care of all loads including wind and seismic during erection. Any failure to make proper and adequate provisions for loads during erection shall be solely the responsibility of the Contractor.
- .6 The Contractor shall be responsible for the design of all hooks, erection connections and handling gear.
- .7 Whenever piles of materials, erection equipment, or other loads are carried during erection, proper provision shall be made to take care of stresses resulting from same. All construction loads shall be adequately distributed so as not to exceed the capacity of any member.
- .8 Structural steel shall be assembled and erected in accordance with the approved erection drawings and specified reference Standards.
- .9 Structural steel work on concrete shall be carefully located at the proper grade and rigidly secured in place, using steel shims. Spaces under the steel shall then be filled with nonshrink premix grout as soon as possible, and before placing any concrete toppings or precast concrete units.
- .10 Plumb, level and align individual members of steel work as specified in CSA S16.
- .11 The various members forming parts of complete frame or structure after being assembled shall be aligned and adjusted accurately before being fastened.
- .12 Bearing surfaces and surfaces which will be in permanent contact shall be cleaned before the members are assembled.

- .13 Temporary bolts, clips and angles etc. used to facilitate erection shall be removed unless noted otherwise on the drawings.

3.4 TEMPORARY FLOORING

- .1 Provide all temporary flooring, planking and scaffolding necessary in connection with erection of structural steel, or support of erection machinery in accordance with governing regulations and by-laws.

3.5 WELDING

- .1 Welding shall be done by the shielded metal-arc method in accordance with the requirements CSA W59. The welding operators shall be currently certified under CSA W47.1 for the work they are performing.
- .2 Submit, when requested, welding procedures prepared and sealed by a Specialty Structural Engineer for review.
- .3 Surfaces to be welded shall be free from loose scale, rust, paint, or other foreign matter. Where weld material is deposited in two (2) or more layers, each layer shall be cleaned before the next layer is deposited. Care shall be taken to minimize stresses due to heat expansion, contraction and distortion by using proper sequence in welding and by approved methods.
- .4 Appearance, quality of welds made, methods of correcting defective work shall be in accordance with CSA W59.
- .5 Welding of reinforcing bars to structural steel as per CSA W186.

3.6 COMPLETION

- .1 The Specialty Structural Engineer responsible for the sealed shop drawings, or his representative shall visit the site to review in place connections and components designed by that Specialty Structural Engineer to ensure substantial compliance with his sealed shop drawings. He shall then submit a sealed and signed letter of substantial compliance to the Departmental Representative and Structural Engineer.
- .2 On completion of the work of this section, all protection erected in conjunction with the structural steel work shall be removed, all damage to this work and adjoining work shall be made good and all surplus materials and debris and all tools, plant and equipment shall be removed from the site.

END OF SECTION 051200

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 03 30 00 – Cast-in-Place Concrete
- .2 Section 05 12 00 – Structural Steel Framing
- .3 Section 06 10 00 – Rough Carpentry
- .4 Section 09 21 16 – Gypsum Board Assemblies
- .5 Section 09 91 00 – Painting

1.2 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM A53/A53M-12, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - .2 ASTM A153/A153M-16a, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - .3 ASTM A269/A269M-15a, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
 - .4 ASTM A276/A276M-17, Standard Specification for Stainless Steel Bars and Shapes.
 - .5 ASTM A307-14, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
 - .6 ASTM A653/A653M-15e1, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .7 ASTM A780/A780M-09(2015), Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 - .8 ASTM A666-15, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar.
 - .9 ASTM B221-14, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - .10 ASTM B632/B632M-15, Standard Specification for Aluminum-Alloy Rolled Tread Plate.
 - .11 ASTM F593-13ae1, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
 - .12 ASTM F3125/F3125M-15A, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.
- .2 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-G40.20-13/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .2 CAN/CSA-G164-M92 (R2003), Hot Dip Galvanizing of Irregularly Shaped Articles.
 - .3 CSA-S16-14, Design of Steel Structures.

- .4 CSA W47.1-09 (R2014), Certification of Companies for Fusion Welding of Steel.
- .5 CSA W48-14, Filler Metals and Allied Materials for Metal Arc Welding.
- .6 CSA W59-13, Welded Steel Construction (Metal Arc Welding), Includes Update No. 1 (2014), Update No. 3 (2015), Update No. 4 (2015).
- .3 National Association of Architectural Metal Manufacturers (NAAMM)
 - .1 NAAMM AMP 555-92, Code of Standard Practice for the Architectural Metal Industry (Including Miscellaneous Iron).
- .4 The Environmental Choice Program
 - .1 UL 2768, Architectural Surface Coatings.
 - .2 UL 2760, Surface Coatings - Recycled Water-Borne.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-Installation Meetings: convene pre-installation meeting in accordance with Section 01 31 19 – Project Meetings to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions.

1.4 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittals:
 - .1 Submit manufacturer's printed product literature, specifications and data sheets.
 - .2 Provide two copies of WHMIS MSDS - Material Safety Data Sheets in accordance with WHMIS acceptable to Labour Canada, and Health and Welfare Canada and indicate VOC content for:
 - .1 Finishes, coatings, primers and paints.
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittals:
 - .1 Indicate materials, core thicknesses, finishes, connections, joints, method of anchorage, number of anchors, supports, reinforcement, details, and accessories.
 - .2 For items where design is delegated to fabricator, provide shop drawings signed and sealed by the professional engineer registered in Province of Work, responsible for the design as indicated in Section 01 35 00.

1.5 QUALITY ASSURANCE

- .1 Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Certificates: Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .3 Detail and fabricate metal fabrications in accordance with the NAAMM AMP 555.

- .4 Perform Work to the highest standard of modern shop and field practice, by personnel experienced in this Work. Accurately fit joints and intersecting members in true planes with adequate fastening. Build and erect the Work plumb, true, square, straight, level, accurate to the sizes shown, and free from distortion or defects.
- .5 Fabricator Qualifications: A firm experienced in producing metal fabrications similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- .6 Welding: Qualify procedures and personnel according to the following:
 - .1 Welders shall be qualified by Canadian Welding Bureau for classification of work being performed.
 - .2 The fabricator shall be certified to CSA W47.1, Division 1 or 2.1.
 - .3 Do welding inspection to CSA W178.
 - .4 Resistance welding: to CSA W55.3.
 - .5 Fusion welding: to CSA W59.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Exercise due care in storing, handling and erecting all materials and support all materials properly at all times so that no piece will be bent, twisted or otherwise damage structurally or visibly.
- .2 Correct damaged material and where the Departmental Representative deems damage irreparable, replace the affected items at no additional expense to the Departmental Representative or Owner.
- .3 Apply protective covering to face of all exposed finished metalwork before it leaves shop, covering to remain until item installed.
- .4 Fabricate large assemblies so they can be safely and easily transported and handled to their place of installation.

1.7 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Waste Management and Disposal.

1.8 JOB CONDITIONS

- .1 Coordinate this Work with the remainder of the Work and exercise the necessary scheduling to ensure that all Work is carried out and all items incorporated during the appropriate construction phase.
- .2 Provide instructions and drawings to other trades for setting bearing plates, anchors bolts, and other members that are built in to work of other trades.
- .3 Protect other Sections of the Work from damage by this Section of the Work.

Part 2 Products

2.1 MATERIALS

- .1 Steel sections and plates: to CAN/CSA-G40.20/G40.21, Grade 300W.

- .2 Hollow Structural Sections: In accordance with CAN/CSA G40.20/G40.21, Grade 350W, Class C.
- .3 Steel pipe: to ASTM A53/A53M, standard weight (Schedule 40), unless another weight is indicated or required by structural loads, galvanized finish.
- .4 Welding materials: to CSA W59.
- .5 Welding electrodes: to CSA W48 Series.
- .6 Fasteners: Bolts, nuts, washers, rivets, lock washers, anchor bolts, machine screws, and machine bolts.
 - .1 Unfinished fasteners: In areas not exposed to public, use unfinished bolts conforming to ASTM A307, Grade A, with hexagon heads and nuts. Supply bolts of lengths required to suit the thickness of the material being joined, but not projecting more than 6 mm beyond nut, without the use of washers.
 - .2 Finished fasteners:
 - .1 In areas exposed to public use, bolts, nuts, washers, rivets, lock washers, anchor bolts, machine screws and machine bolts to be hot dip galvanized in accordance with ASTM A153/A153M or CAN/CSA-G164.
 - .2 For joining stainless steel components use stainless steel fasteners of same type.
- .7 Structural bolts: to ASTM F3125.
- .8 Stainless steel fasteners, washers and nuts: to ASTM F593, 18-8 austenitic stainless steel (Grade 8 - B8/B8A), sized as required for purpose intended, or as otherwise indicated. Cold finished: Condition B, cold worked, per ASTM A276.
- .9 Grout: non-shrink, non-metallic, flowable, 15 MPa at 24 hours.

2.2 FABRICATION

- .1 Fabricate work square, true, straight and accurate to required size, with joints closely fitted and properly secured.
- .2 Use self-tapping shake-proof flat, round, or oval headed screws on items requiring assembly by screws or as indicated.
- .3 Where possible, fit and shop assemble work, ready for erection.
- .4 Ensure exposed welds are continuous for length of each joint. File or grind exposed welds smooth and flush. Seal exterior steel fabrications to provide corrosion protection in accordance with CAN-S16.
- .5 Welding is to conform to CSA W59 and the fabricator certified to CSA W47.1. Include for welding inspection in the Contract.
- .6 File or grind all exposed welds smooth and flush. Repair or fill all pits, cracks and holes. Grind and polish all handrails to a smooth, even surface. Smooth all inside corners, returns.
- .7 Insulate when necessary to prevent electrolysis due to metal to metal contact or metal to masonry or concrete contact. Use bituminous paint or other approved method.

- .8 Provide fastenings, including anchor bolts, bolts, lag screws, expansion bolts, straps, brackets, etc. required for the fabrication and erection of work of this Section.

2.3 FINISHES

- .1 Prior to priming steel, prepare all surfaces in conformance with SSPC SP-3 – Power Tool Cleaning for non-exposed locations and SSPC SP-5 – White-metal Blast Cleaning for exposed architectural finished locations. Adjust blast grit to suit primer coat thickness specified in Section 09 91 00 – Painting.
- .2 Hot dip galvanizing: galvanize steel, where indicated, to ASTM A123, minimum zinc coating of 600 g/m². (Severe, unprotected exposures)
- .3 Electrolytic galvanizing: galvanize steel, where indicated, to ASTM A591, minimum zinc coating of 180 g/m². (Non-severe, unprotected exposures)
- .4 Wipe coat galvanizing: galvanize steel, where indicated to CSA G189, minimum zinc coating of 75 g/m². (Non-severe, protected exposures)
- .5 Shop Primers: Provide primers that are compatible with paint systems specified.
- .6 Touch up galvanized surfaces with zinc rich coating, to ASTM A780: DOD-P-21035 zinc rich paint, minimum DFT 8 mils.
- .7 Zinc Rich Paint: Conforming to DOD-P-21035 zinc rich paint.
 - .1 Clean metal to equivalent of commercial sand blast SSPC-SP6, remove sandblast in residue.
 - .2 Apply one coat of zinc rich paint to surfaces exposed after assembly to minimum dry film thickness of 60 µm (2.5 mil). Apply coating immediately after cleaning and over primer.
- .8 Isolation Coating: Apply an isolation coating to contact surfaces in contact with cementitious materials, wood materials and dissimilar metals except stainless steel.
- .9 Paint: Prepare the Work and paint in accordance with CAN/CSA-S16, primed ready for site finish as specified in Section 09 91 00 – Painting. Leave surfaces to be welded unpainted.
- .10 Urethane Enamel Finish, primed as specified in Section 09 91 00 – Painting, ready for site finish. Leave surfaces to be welded uncoated.
 - .1 Base metal galvanized steel or aluminum, blast clean to SP-6 Commercial, apply Quick Dry primer for specific base metal.
 - .2 Finish with 2 coats Quick Dry Urethane Enamel.
- .11 Chromium plating: chrome on steel with plating sequence of 0.009 mm thickness of copper 0.010 mm thickness of nickel and 0.0025 mm thickness of chromium.

2.4 ROUGH HARDWARE

- .1 Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels, and other miscellaneous steel and iron shapes as required. Fabricate items to sizes, shapes, and dimensions required.

2.5 MISCELLANEOUS FABRICATIONS

- .1 Miscellaneous Framing and Supports: Provide steel framing and supports for applications indicated that are not a part of structural steel framework, as required to complete work.
- .2 Fabricate units to sizes, shapes, and profiles indicated and required to receive adjacent other construction retained by framing and supports. Fabricate from structural steel shapes, plates, and steel bars of welded construction using mitred joints for field connection. Cut, drill, and tap units to receive hardware, hangers, and similar items.
- .3 Equip units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units must be installed after concrete is placed.
- .4 Miscellaneous Steel Trim: Provide shapes and sizes indicated for profiles shown. Unless otherwise indicated, fabricate units from structural steel shapes, plates, and steel bars, with continuously welded joints and smooth exposed edges. Use concealed field splices wherever possible. Provide cutouts, fittings, and anchorages as required for coordination for assembly and installation with other work.

2.6 ANGLE LINTELS

- .1 Steel angles: galvanized, sizes indicated for openings. Provide 150 mm minimum bearing at ends.
- .2 Weld or bolt back-to-back angles to profiles as indicated.
- .3 Finish: shop painted where exposed.

Part 3 Execution

3.1 ERECTION

- .1 Install Work in accordance with manufacturer's/fabricator's written instructions and Contract Documents.
- .2 Do welding work in accordance with CSA W59 unless specified otherwise.
- .3 Supply finished items to be built-in to those trades along with instructions for proper installation.
- .4 Apply architectural metal work using hidden mechanical fasteners. Installation shall be by skilled Architectural metal workers experienced in highest quality work.
- .5 Fasteners to draw adjoining sections together in proper, true alignment, and are capable of field adjustment.
- .6 All fasteners, mountings to be non-loosening and installed so that they will be hidden at completion.
- .7 Install all Work to true, straight lines, accurate to profile, all properly aligned.
- .8 Isolate dissimilar metals in a manner approved by the Departmental Representative to prevent electrolytic action or corrosion.
- .9 Install finish hardware supplied under other Sections required for completion of components of this Section.

- .10 Erect metalwork square, plumb, straight, and true, accurately fitted, with tight joints and intersections.
- .11 Provide suitable means of anchorage acceptable to Departmental Representative such as dowels, anchor clips, bar anchors, expansion bolts and shields, and toggles.
- .12 Make field connections with high tensile bolts to CSA-S16.1 and weld to prevent loosening.
- .13 Hand items over for casting into concrete or building into masonry to appropriate trades together with setting templates.
- .14 Touch-up rivets, field welds, bolts and burnt or scratched surfaces after completion of erection with primer.
- .15 Repair galvanized areas damaged by welding, flame cutting or during handling, transport or erection in accordance with ASTM A780. Touch-up with organic zinc-rich paint to DOD-P-21035 zinc rich paint, minimum DFT 8 mils.

3.2 CHANNEL FRAMES

- .1 Install steel channel frames to openings as indicated.

3.3 MISCELLANEOUS ITEMS

- .1 Provide steel angle frame, hanging rods and bracing for supporting bulkheads and shelving.
- .2 Provide bracket backing supports for vanities.
- .3 Steel angle masonry supports as detailed.
- .4 Supply and install miscellaneous metal items as indicated or specified, or as otherwise required for a complete job, in accordance with the design intent of the project.

3.4 CLEANING

- .1 Perform cleaning after installation to remove construction and accumulated environmental dirt.
- .2 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 07 27 19 – Sheet Membrane Air and Vapour Barrier
- .2 Section 07 52 00 – Modified Bituminous Membrane Roofing
- .3 Section 07 62 00 – Sheet Metal Flashing and Trim
- .4 Section 09 91 00 - Painting

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)
 - .1 ANSI/NPA A208.1-2009, Particleboard.
 - .2 ANSI A208.2-2009, Medium Density Fibreboard (MDF) for Interior Applications.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A307-14, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength.
 - .2 ASTM A653/A653M-15e1, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
 - .3 ASTM C578-16, Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
 - .4 ASTM C954-15, Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness
 - .5 ASTM C1289-16, Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
 - .6 ASTM D1761-12, Standard Test Methods for Mechanical Fasteners in Wood.
 - .7 ASTM D5055-16, Standard Specification for Establishing and Monitoring Structural Capacities of Prefabricated Wood I-Joists.
 - .8 ASTM D5456-17, Standard Specification for Evaluation of Structural Composite Lumber Products.
 - .9 ASTM E1333-14, Standard Test Method for Determining Formaldehyde Concentrations in Air and Emission Rates from Wood Products Using a Large Chamber.
- .3 American Wood Preservers Association (AWPA):
 - .1 AWPA Book of Standards, 2016
- .4 Canadian General Standards Board (CGSB)
 - .1 [CAN/CGSB-11.3-M87](#), Hardboard.
 - .2 [CAN/CGSB-51.32-M77](#), Sheathing, Membrane, Breather Type.
 - .3 [CAN/CGSB-51.34-M86](#), Vapour Barrier, Polyethylene Sheet for Use in Building Construction.
- .5 Canadian Standards Association (CSA International)

- .1 CSA A123.2-03 (R2013), Asphalt-Coated Roofing Sheets.
- .2 CAN/CSA-A247-M86 (R1996), Insulating Fiberboard.
- .3 CSA B111-1974(R2003), Wire Nails, Spikes and Staples.
- .4 CAN/CSA-G164-M92(R2003), Hot Dip Galvanizing of Irregularly Shaped Articles.
- .5 CAN/CSA O80 Series-15, Wood Preservation
- .6 CSA O112 Series-M1977 (R2006), CSA Standards for Wood Adhesives.
- .7 CSA O121-17, Douglas Fir Plywood.
- .8 CSA O122-16, Structural Glued-Laminated Timber.
- .9 CSA O141-05 (R2014), Softwood Lumber.
- .10 CSA O151-17, Canadian Softwood Plywood.
- .11 CSA O153-13, Poplar Plywood.
- .12 CAN/CSA-O325-16, Construction Sheathing.
- .13 CSA O437 Series-93(R2011), Standards on OSB and Waferboard
- .6 National Lumber Grading Association (NLGA):
 - .1 NLGA SPS2-2010, Special Products Standards on Machine Stress-Rated Lumber.
 - .2 Standard Grading Rules for Canadian Lumber 2010.
- .7 South Coast Air Quality Management District (SCAQMD), California State (SCAQMD)
 - .1 SCAQMD Rule 1113-16, Architectural Coatings.
 - .2 SCAQMD Rule 1168-05, Adhesive and Sealant Applications.
- .8 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S770-15, Standard Test Method for Determination of Long-Term Thermal Resistance of Closed-Cell Thermal Insulating Foams.
 - .2 CAN/ULC-S701-11, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.
 - .3 CAN/ULC S102.2-10, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.3 DEFINITIONS

- .1 For the purpose of this project the following definitions shall apply:
 - .1 Structural Light Framing: All horizontal and vertical load bearing framing including members indicated as “Studs” on the drawings shall be considered to be No. 2 Grade and better and shall be used throughout unless prior approval is provided by the Departmental Representative.
 - .2 Stud Framing: Vertical framing members of non-load bearing wall systems may be considered as No. 3 or Stud Grade and may only be used where the Departmental Representative gives prior approval. Use of No. 3 and Stud Grade framing material will not be allowed for any horizontal applications.

1.4 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittals:

- .1 Submit manufacturer's printed product literature, specifications and data sheets.
- .2 Submit MSDS sheets or official manufacturer literature stating no urea-formaldehyde was used in the manufacturing of composite wood.
- .2 Submit samples in accordance with Section 01 33 00 – Submittals.
 - .1 Submit 100 mm x 300 mm samples of cedar to receive finish, to the Departmental Representative for review.
- .3 Quality Control Submittals: Prior to covering exterior sheathing and shear walls, request structural engineer to review nailing patterns and provide confirmation report to Departmental Representative.

1.5 QUALITY ASSURANCE

- .1 Lumber shall be graded and stamped by an agency certified by Canadian Lumber Standards Accreditation Board.
- .2 Plywood, particleboard, OSB and wood based composite panels in accordance with CSA and ANSI standards.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver wood products bundled or crated to provide adequate protection during transit. Inspect wood products for damage upon delivery and remove and replace damaged materials.
- .2 Store materials a minimum of 150 mm off the ground on blocking. Keep materials under cover and dry. Provide for air circulation within and around stacks and under temporary coverings.
- .3 Protect sheet materials to prevent breaking of corners and damage to surfaces.

1.7 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Waste Management and Disposal.

Part 2 Products

2.1 LUMBER

- .1 Lumber: Stud Grade to CAN/CSA-O141, softwood, S-P-F, S4S, graded and stamped in accordance with National Lumber Grading Association (NLGA) Standard Grading Rules for Canadian Lumber and as follows:
 - .1 Moisture Content: maximum 19% at time of installation.
 - .2 Maximum moisture content when used for attachment of drywall: 16%.
 - .3 Meeting requirements of the Building Code.

2.2 PANEL MATERIALS

- .1 Sheathing for structural shear wall and diaphragms:
 - .1 Plywood: Douglas Fir (DFP) or Canadian Softwood (CSP), Sheathing Grade, to CSA O121 or O151, thickness as indicated on drawings.

- .2 Other sheathing:
 - .1 Fire Rated Plywood Panels to CSA O325, Class A fire retardant produced under Performance Standard PS-1, certified by the American Plywood Association.
 - .1 Acceptable Materials:
 - .1 Purekor Fire Retardant Plywood.

2.3 MISCELLANEOUS LUMBER

- .1 Provide lumber for support or attachment of other construction, including furring, blocking, nailing strips, ground, rough bucks, cants, curbs, fascia, backing sleepers, and similar members.
- .2 Fabricate miscellaneous lumber from dimension lumber of sizes indicated, and into shapes shown on drawings.
- .3 Moisture Content: 19% maximum for lumber items not specified to receive wood preservative treatment.
- .4 Grade: for dimension lumber sizes provide No. 2 or Standard grade lumber per NLGA. For board-sized lumber, provide sheathing grade, S2S.

2.4 WOOD PRESERVATIVE

- .1 Where lumber or plywood is indicated as preservative treated or is specified to be treated, treated in accordance with CAN/CSA O80.9M and AWWA.
- .2 Wood preservatives containing arsenic or chromium are not permitted.
- .3 Pressure treat above ground items with waterborne preservatives to minimum retention of 4.0 kg/m³. After treatment, kiln-dry lumber and plywood to maximum moisture content of 19% and 15% respectively. Treat indicated items and the following:
 - .1 Wood cants, nailing strips, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapour barriers, and waterproofing.
 - .2 Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry and concrete.
 - .3 Wood framing members less than 460 mm above grade.
 - .4 Wood floor plates installed over concrete slabs directly in contact with earth.
- .4 Pressure treat wood members in contact with ground or freshwater with waterborne preservatives to minimum of 6.4kg/m³
- .5 Fire-Retardant Treatment: to CAN/SCA O80.9M, CAN/CSA O80.20M and CAN/CSA O80.27M, pressure impregnated, and as follows:
 - .1 Flame Spread Classification: FSC 25 maximum.
 - .2 Smoke developed of not more than: 75.
- .6 Complete fabrication of treated items before treatment where possible. If cut after treatment apply field treatment to cut surfaces.
- .7 Wood Preservatives: Maximum allowable VOC limit 350 g/L in accordance with SCAQMD Rule #1113 - Architectural Coatings.

2.5 ACCESSORIES

- .1 Sealants: in accordance with Section 07 92 00 – Sealants.
 - .1 Maximum allowable VOC limit 250 g/L in accordance with SCAQMD Rule 1168.
- .2 General purpose adhesive: to CSA O112 Series.
 - .1 Maximum allowable VOC limit 70 g/L in accordance with SCAQMD Rule 1168.
- .3 Nails, spikes and staples: to CSA B111, hot dipped galvanized for exterior work and pressure preservative and fire retardant treated materials.
- .4 Surface Applied Wood Preservative:
 - .1 Containing minimum 5% clear pentachlorophenol in accordance with CAN/CSA-O80 Series-M89.
 - .2 Apply minimum of 2 coats applied in accordance with manufacturers written instructions.
 - .3 Acceptable materials: Osmose-Pentox Inc.
- .5 Rough Hardware (bolts, nuts, washers, etc.): Hot dip galvanized in conformity to CSA G164 or Grade A low carbon steel, conforming to ASTM A307.
- .6 Proprietary fasteners: toggle bolts, expansion shields and lag bolts, screws and lead or inorganic fibre plugs, explosive actuated fastening devices, recommended for purpose by manufacturer.
- .7 Joist hangers: minimum 1 mm thick sheet steel, galvanized ZF001 coating designation.
- .8 Nailing discs: flat caps, minimum 25 mm diameter, minimum 0.4 mm thick, sheet metal, formed to prevent dishing. Bell or cup shapes not acceptable.
- .9 Expanding foam sealant:
 - .1 Acceptable Materials:
 - .1 GREAT STUFF PRO™ by Dow Canada
 - .2 Hilti (Canada) Ltd. CF Filler Foams.
 - .3 Approved alternates.

2.6 FASTENER FINISHES

- .1 Galvanizing: to CAN/CSA-G164, use galvanized fasteners for exterior work, pressure-preservative, and fire-retardant treated lumber.

Part 3 Execution

3.1 INSTALLATION

- .1 Comply with requirements of Building Code supplemented by following paragraphs.
- .2 Install members true to line, levels and elevations, square and plumb.
- .3 Construct continuous members from pieces of longest practical length.

- .4 Install spanning members with "crown-edge" up.
- .5 Select exposed framing for appearance. Install lumber and panel materials so that grade-marks and other defacing marks are concealed or are removed by sanding where materials are left exposed.
- .6 Install blocking at locations indicated to support washroom accessories.
- .7 Install wall sheathing in accordance with manufacturer's printed instructions.
- .8 Install roof sheathing in accordance with requirements of ABC.
- .9 Install furring and blocking as required to space-out and support casework, cabinets, wall and ceiling finishes, facings, fascia, soffit, siding, electrical equipment mounting boards, and other work as required.
- .10 Install furring to support siding applied vertically where there is no blocking and where sheathing is not suitable for direct nailing.
 - .1 Align and plumb faces of furring and blocking to tolerance of 1:600.
- .11 Install rough bucks, nailers and linings to rough openings as required to provide backing for frames and other work.
- .12 Install wood cants, fascia backing, nailers, curbs and other wood supports as required and secure using galvanized fasteners.
- .13 Install sleepers as indicated.
- .14 Use dust collectors and high quality respirator masks when cutting or sanding wood panels.

3.2 WOOD FRAME CONSTRUCTION

- .1 Space framing members at 305 mm ϕ/c , or as indicated otherwise on drawings. Construct members of continuous pieces of longest possible length.
- .2 Provide 38 x 89 mm blocking at 610 mm ϕ/c between engineered floor joists for lateral support of wall plates where walls run parallel to joists.
- .3 Make allowance for erection stresses. Securely brace members in place to maintain plumb and true until permanently fixed and held to structure.
- .4 Install fire-blocking as detailed.
- .5 Fabricate wood frame construction to the requirements of the Building Code, Part 9, except where more stringent requirements are indicated on the drawings.
- .6 Minimum sizes and spacing of members, thickness of materials, allowable species and lumber grades, shall meet the requirements of the above noted standards, unless indicated or specified otherwise.
- .7 Minimize cutting of framing members for pipes, etc. by prior consultation with other trades. Cutting limitations in accordance with Part 9 of the Building Code.
- .8 Construct framing as necessary to accommodate the work of other trades.

3.3 ERECTION

- .1 Frame, anchor, fasten, tie and brace members to provide necessary strength and rigidity.
- .2 Countersink bolts where necessary to provide clearance for other work.

- .3 Use nailing disks for soft sheathing as recommended by sheathing manufacturer.

3.4 POWER, TELECOMMUNICATIONS [AND DATA] PANEL BOARDS

- .1 Install 19 mm fire rated fir plywood boards on all walls in telephone and data rooms receiving wiring and equipment; minimum 1220 mm x 2440 mm panels on periphery walls over 300 mm wide, mounted 150 mm off of finished floor.

END OF SECTION

Part 1 General**1.1 REFERENCES**

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated, Galvanized or Zinc-Iron Alloy-Coated Galvanealed by the Hot-Dip Process.
 - .2 ASTM D1761, Standard Test Methods for Mechanical Fasteners in Wood.
 - .3 ASTM D5055, Specification for Establishing and Monitoring Structural Capacities of Prefabricated Wood I-Joists.
 - .4 ASTM D5456, Specification for Evaluation of Structural Composite Lumber Products.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-71.26, Adhesive for Field-Gluing Plywood to Lumber Framing for Floor Systems.
- .3 Canadian Standards Association (CSA)
 - .1 CAN/CSA-086 – Engineering Design in Wood.
 - .2 CSA B111-1974, Wire Nails, Spikes and Staples.
 - .3 CAN/CSA-G164, Hot Dip Galvanizing of Irregularly Shaped Articles.
 - .4 CSA O112 Series, CSA Standards for Wood Adhesives.
 - .5 CSA O121, Douglas Fir Plywood.
 - .6 CAN/CSA-O141, Softwood Lumber.
 - .7 CSA O151, Canadian Softwood Plywood.
 - .8 CAN/CSA-O325, Construction Sheathing.
 - .9 CAN3-O437, Standards on OSB and Waferboard.
 - .10 CSA O80.20, Fire-Retardant Treatment of Lumbering Pressure Processes. This Standard applies to the fire-retardant treatment of lumber by pressure processes. Fire-Retardant Treatment of Lumber by Pressure Processes. This is not a stand alone specification.
 - .11 CSA O80.27, Fire-Retardant Treatment of Plywood by Pressure Processes. This Standard covers the fire-retardant treatment of Douglas Fir, hardwood, softwood, and Poplar plywood by pressure processes.

Fire-Retardant Treatment of Plywood by Pressure Processes. This not a stand alone specification.

.12 CSA O80.201, Standard for Hydrocarbon Solvents for Preservatives. This Standard covers hydrocarbon solvents for preparing solutions of preservatives.- This is not stand alone specification

.13 CSA O322, Procedure for Certification of Pressure-Treated Wood Materials for Use in Preserved Wood Foundations.

.4 National Lumber Grades Authority (NLGA)

.1 Standard Grading Rules for Canadian Lumber.

.5 American Wood-Preservers' Association (AWPA)

.1 AWPA M2, Standard Inspection of Treated Wood Products.

.2 AWPA M4, Standard for the Care of Preservative-Treated Wood Products.

1.2 DESIGN REQUIREMENTS

.1 The design intent of the structural roof framing members indicated on the structural drawings is to support a single-sloped roof design.

.1 The sloped roof design results in variable heights of the supporting columns and walls throughout the building.

.2 Three dimensional shop drawings are to be prepared and submitted with such level of detail to prove that the structural framing design intent is achieved prior to fabrication, delivery and construction.

.2 Unless otherwise noted, connections shall be designed by the Contractor to the reference Standards by the Specialty Structural Engineer.

.3 Design details and connections in accordance with requirements of CAN/CSA-O86 to resist forces, moments, and shears and allow for movements indicated.

.4 Where connections are detailed, use connection of the type and detail shown on the drawings. Modifications to the specified connection types and details will not be permitted without prior approval.

.5 Connections for wind or seismic lateral load-resisting elements, such as bracing and drag struts, and others so noted on the structural drawings may be designed as bearing connections but shall be pre-tensioned.

.6 Use standard connection types where connections are not detailed on the structural drawings.

.7 Design shall be for the forces and loads shown on the drawings and shall allow for the effects of beam deflections. If forces or loads are not given, the connection

shall be designed for the maximum uniform distributed load that the member can carry for the span shown.

- .8 Structural members spliced for ease of fabrication or transportation shall have splices designed to develop the full strength and stiffness of the member. Splices shall be subject to non-destructive testing. The cost for such testing shall be borne by the Contractor.
- .9 Shear connections: Select or design connections to support reaction from maximum uniformly distributed load that can be safely supported by beam in bending, provided no point loads act on beam, when shears are not indicated.
- .10 Submit sketches and design calculations stamped and signed by qualified professional engineer licensed in Province of British Columbia, Canada for non-standard connections.

1.3 QUALITY ASSURANCE

- .1 Lumber by grade stamp of an agency certified by Canadian Lumber Standards Accreditation Board.
- .2 Plywood, particleboard, OSB and wood based composite panels in accordance with CSA and ANSI standards.

1.4 SHOPDRAWINGS

- .1 The design intent of the structural roof framing members indicated on the structural drawings is to support a single-sloped roof design.
 - .1 The sloped roof results in variable heights of the supporting columns and walls throughout the building.
 - .2 Three dimensional shop drawings are to be prepared and submitted with such level of detail to prove that the structural framing design intent is achieved prior to fabrication, delivery and construction.
- .2 Submit “design” drawings for review summarizing the proposed connection details to be used on the project. These drawings to be prepared by, or under supervision of, the Specialty Structural Engineer and submitted for review before start of shop drawing production. These design drawings shall show the complete connection and:
 - .1 How the connection assembly fits with the connected members.
 - .2 Sizes of engineered wood products and structural composite lumber complete with connection.
 - .3 Capacities of the connection.
 - .4 Assumed eccentricities, lines of action of forces, etc.
- .3 Submit shop drawings prepared under direction of the Specialty Structural Engineer. Drawings of components and connections designed by the Contractor

shall be sealed and signed by this Specialty Structural Engineer or a letter shall be submitted at the end of the project signed and sealed by this Specialty Structural Engineer. The letter shall identify what was designed by the Specialty Structural Engineer and list the final shop drawings by number with dates and revision numbers.

- .4 Shop drawings shall show complete shop and erection details necessary for fabrication and erection of the component parts of the structure, including cuts, copes, connections, holes, fasteners, splices and location, type, size and extent of all connections. Splices not shown on the shop drawings will be rejected.
- .5 Prepare handling and erection shop drawing to be used by the general contractor for the purpose of erecting the visually exposed members. The shop drawings shall identify, as a minimum, the following:
 - .1 Methods of on-site storage.
 - .2 Methods of hoisting, showing locations of slings and padding.
 - .3 Methods of field cutting and field drilling bolt holes, including methods of protecting wood stain.
 - .4 Approved machine bolts, timber rivets and lag screws as well as the approved method of installing bolts, timber rivets and screws.
 - .5 Precautions to minimize surface checking
- .6 Provide a shop drawing clearly locating all anchor bolts, embedded plates, baseplates, etc.
- .7 Provide setting drawings, templates and directions for the installation of anchor bolts, plates and other devices.
- .8 Review of the shop drawings is intended as an assistance to the Contractor and does not relieve the Contractor of his responsibility for the completeness or accuracy of his work and its conformance with the contract documents.
- .9 Fabrication that commences prior to shop drawing review is at the risk of the Contractor.
- .10 Clearly identify on the shop drawing all revisions, changes, or modifications.
- .11 Resubmit reviewed shop drawings where noted in the review stamp, or when the Contractor makes revisions for his own purposes.
- .12 Allow at least two (2) weeks for shop drawing review.
- .13 Structural drawings are not prepared to be used as erection or shop drawings.

1.5 SUBMITTALS

- .1 Submit two (2), 2.4 m long full cross section, samples of the required finished exposed timber elements to be approved by the Departmental Representative.

One (1) sample shall remain with the Supplier and one (1) sample shall remain on-site with the Departmental Representative. Samples will be used by the Departmental Representative as a basis for acceptance of finishes of exposed timber elements as installed. Elements, in the opinion of the Departmental Representative, not matching the sample are to be replaced at no cost.

- .2 Submit documentation of where the lumber was harvested, processed and manufactured. Where possible, subject to remaining within budget and on schedule, materials should be selected from within an 800 km (500-mile) radius or be shipped by rail or water from within 2400 km (1500 miles) of the project site.

1.6 SUPPLY OF ALTERNATE PRODUCTS

- .1 Should the sections shown on the drawings not be procurable, or should substitution for those sections be desired, sections of equivalent strength, may be substituted if approved. In such cases full particulars, thereof must be submitted prior to the closing of Bid. Material substitutions after the closing of Bid, if accepted, will be at the Contractor's cost.

1.7 DELIVERY AND HANDLING

- .1 Apply protective sealer to visually exposed timbers before shipping unless specified otherwise.
- .2 Wrap quality grade members prior to leaving plant with a moisture resistant wrapping. Use padded, non-marring slings for handling visually exposed timbers.
- .3 Protect corners with wood blocking.
- .4 Slit underside of membrane covering during storage at site. Do not deface member.
- .5 Visually exposed timbers should be stored in a covered area, if this is not possible, a level storage area must be prepared.
- .6 Care must be taken not to rip or otherwise damage the product wrapping. The colour of the product can be adversely affected by direct sun light or exposure to rainwater.
- .7 Store visually exposed timbers units and protect from weather, Beams should be set on supports with a minimum thickness of 6" (150mm), at an approximate spacing of 10' (3m) on centre.
- .8 If beams need to be stacked, they should be separated by spacers with a width of no less than 1 1/2" (38mm) and spaced at 10' (3m) on centre.
- .9 Wrapping should be slit or punctured on the underside to permit the draining of water resulting from condensation or precipitation.
- .10 All members should be covered with a loosely fitting tarpaulin
- .11 Make adequate provision for delivery and handling stresses.

1.8 FIELD REVIEW

- .1 The Specialty Structural Engineer responsible for shop drawings, or the Specialty Structural Engineer's representative, shall visit the site to review in place the connections and components designed by that Specialty Structural Engineer. The Specialty Structural Engineer shall be satisfied or take steps to ensure that these connections and components substantially comply with the Specialty Structural Engineer's design. The Specialty Structural Engineer shall then provide a sealed and signed letter to this effect.
- .2 The Contractor shall advise the Specialty Structural Engineer of the scheduling of all field work pertaining to this Project. The Contractor shall permit the Specialty Structural Engineer full access to the site, for the purpose of carrying out his work and he shall provide assistance required to aid in the performance of the inspection.
- .3 Provide safe access and working areas for field review on site, as required by the Specialty Structural Engineer.
- .4 Submit field review reports within 1 week of completion of inspection.

Part 2 Products**2.1 BUILDING FRAMING AND STRUCTURAL MATERIALS**

- .1 Lumber: unless specified otherwise, softwood, S4S, moisture content 19% (S-dry) or less in accordance with following standards:
 - .1 CAN/CSA-O141.
 - .2 NLGA Standard Grading Rules for Canadian Lumber.
- .2 Glued end-jointed (finger-jointed) lumber is not acceptable.
- .3 All visually exposed wood elements are classified as "Architecturally Exposed" timber.
 - .1 Due to the visually exposed nature of these elements care and attention to the protection of the exposed finish is a requirement of the project during transportation, storage, handling and erection against damage and moisture.
 - .2 Finish of wood grain to be milled, sanded and rolled using a nylon wheel to enhance the natural graining and remove residual remaining from the saw milling process, grading stamps, lifting, transportation, and the saw blade itself.
 - .3 Kiln dry visually exposed timber elements and store in controlled environment prior to construction to control splitting, checking, and warping and protect the materials during construction from moisture and damage.

- .4 Submit a mockup of the finished wood beam and column complete with connection hardware for review by Departmental Representative and departmental representative prior to fabrication, delivery and construction of the visually exposed timber elements.
 - .5 Apply two (2) Coats of shop applied Cloverdale 59314 Waterborne Alkyd Varnish on all visually exposed members, with a triple coat on the end grain.
 - .6 Apply AnchorSeal II wax-based emulsion sealer at end grain locations of all visually exposed members to minimise end grain checking.
 - .7 See architectural drawings and specifications for additional requirements.
-
- .4 Visually Exposed Rough Sawn Beams to be 305mmx203mm full rough dimensions Douglas Fir (D.Fir) No.1 Grade c/w connections in the locations indicated on the structural drawings. Connect Beams to the top of Columns or drop beams for $T_f = 15\text{kN}$, and $C_f = 250\text{kN}$. See structural drawings for connection concepts.
 - .5 Visually Exposed Rough Sawn Columns to be 203mmx203mm full rough dimensions Douglas Fir (D.Fir) No.1 Grade c/w base plate and top connection in the locations indicated on the structural drawings. Connect Columns to the concrete slab and to roof beams above for $T_f = 15\text{kN}$, and $C_f = 250\text{kN}$. See structural drawings for connection concepts.
 - .6 Built up Posts to be 5Ply 38mmx140mm o/c Douglas Fir (D.Fir) Select Structural Grade in the locations indicated on the structural drawings.
 - .7 Stud Shear Walls to be 38mmx140mm@400mm o/c Douglas Fir (D.Fir) Select Structural Grade c/w 16mm Plywood Sheathing on the exterior side in the locations indicated on the structural drawings. Provide Double bottom plate with pressure treated lower bottom plate. Connect Shear Wall bottom plate to concrete slab/curb using 12mm@1200mm o/c anchor bolts with a minimum embedment of 125mm and a minimum projection of 75mm. Connect Shear Walls through top plates to roof decking as indicated on the structural drawings.
 - .8 Visually Exposed Roof decking to be 89mm deep commercial grade tongue and groove plank decking.
 - .9 Exterior Wall Sheathing to be 16mm Tongue and Groove Plywood.
 - .10 Furring, blocking, nailing strips, grounds, rough bucks, cants, curbs, fascia backing and sleepers:
 - .1 S4S for members receiving finishes, S2S or S4S for members not receiving finishes.
 - .2 Board sizes: Douglas Fir(D.Fir) species, No. 2 grade or better.
 - .3 Dimension sizes: Douglas Fir (D.Fir) species, No. 2 grade or better.

- .4 Post and timbers sizes: Douglas Fir (D.Fir) species, No. 2 grade or better.

2.2 PANEL MATERIALS

- .1 Plywood, OSB and wood based composite panels: to CAN/CSA-O325.0.
- .2 Douglas fir plywood (DFP): to CSA O121, standard construction.
- .3 Canadian softwood plywood (CSP): to CSA O151, standard construction.
- .4 Poplar plywood (PP): to CSA O153, standard construction.

2.3 ACCESSORIES

- .1 Exterior wall sheathing paper: to CAN/CGSB-51.32
- .2 Polyethylene film: to CAN/CGSB-51.34, Type 1, 0.15 mm thick.
- .3 Roll roofing: to CSA A123.2, Type S.
- .4 Subflooring adhesive: to CGSB-71.26, cartridge loaded.
- .5 General purpose adhesive: to CSA O112 Series.
- .6 Nails, spikes and staples: to CSA B111 galvanized.
- .7 Bolts: Galvanized unless indicated otherwise, complete with galvanized nuts and washers.
- .8 Proprietary fasteners: toggle bolts, expansion shields and lag bolts, screws and lead or inorganic fibre plugs, explosive actuated fastening devices, recommended for purpose by manufacturer. All proprietary fasteners to be galvanized or stainless steel.
- .9 Roof sheathing H-Clips: formed "H" shape, thickness to suit panel material.

2.4 FASTENER FINISHES

- .1 Galvanizing: to CAN/CSA-G164, use galvanized fasteners for all interior and exterior work, pressure-preservative treated lumber as indicated on drawings.

2.5 WOOD PRESERVATIVE

- .1 Preservative: to CSA-O80 Series, Alkaline Copper Quaternary (ACQ) tinted green for wood framing concealed in walls and ceilings.

Part 3 Execution

3.1 PREPARATION

- .1 Store wood products as to avoid damage and keep clean.

3.2 FRAMING MEMBERS

- .1 Comply with requirements of NBC 1995 Part 9 supplemented by following paragraphs.
- .2 Install members true to line, levels and elevations, square and plumb. Erect all framing materials forming subsurfaces for wood finishes, drywall, etc. to be straight in any plain with a tolerance of 6 mm in 3 m non cumulative.
- .3 Construct continuous members from pieces of longest practical length.
- .4 Install spanning members with "crown-edge" up.
- .5 Select exposed framing for appearance. Install lumber and panel materials so that grade-marks and other defacing marks are concealed or are removed by sanding where materials are left exposed.
- .6 Ensure that all members are framed, anchored, tied and braced together to provide the strength and rigidity necessary for their end purposes.
- .7 Ensure that at least 50% of length of fasteners penetrate wood materials to which fasteners are secured.
- .8 Secure exterior stud wall sole plates bolted on foundations in strict accordance with design requirements.
- .9 Brace all framing temporarily in place, until braced by complete framing and sheathing.
- .10 Construct openings in stud walls wider than stud spacing by doubling jamb studs with full length cripples having full bearing at bottom of opening and providing minimum 38 mm full bearing for lintel.
- .11 Construct lintels over openings in stud walls with framing lumber set on edge and continuous solid lumber or fir sheathing plywood spacer, spiked together to make up full stud wall thickness, as indicated on structural drawings.
- .12 Provide built-up stud columns at each bearing for built-up timber beam unless noted otherwise. Each built-up column shall consist of the same number of wood studs as the number of wood framing members in each built-up timber beam, unless otherwise noted.
- .13 Double up sill plates at window and similar openings wider than 800 mm in stud walls, provide bearing cripples at jamb studs for sill plate support similar as specified for lintel support preceding.
- .14 Provide 38 x 38 mm wood bridging between joists at bearing locations and at intervals not exceeding 2 m between supports.
- .15 Provide 38 x 150 solid wood blocking in walls to receive washroom accessories, handrails, upper casework, etc. as shown on drawings

3.5 ROOF FRAMING

- .1 Set roof framing with crown up, minimum 3" birdsmouth cut at wall solid support at intermediate beams, vertical cut at ridge to fit ridge board.
- .2 Cut all eaves plumb vertical and true to line.
- .3 Spike all rafters to wall plates, dwarf walls, trusses, ridges, valleys. Install and secure all blocking, bridging, framing. Provide continuous solid blocking for fascia and soffit.
- .4 Provide a minimum of 2 - 38 x 235 mm timber framing members on each side of roof openings, unless noted otherwise. Extend these framing members on two parallel sides of the opening to bear on the nearest adjacent bearing truss or beam.

3.5 ROOF FASCIAS, NAILERS, CURBS

- .1 Install furring and blocking as required to space-out and support casework, cabinets, wall and ceiling finishes, facings, fascia, soffit, siding [electrical equipment mounting boards], and other work as required.
- .2 Install furring to support siding applied vertically [where there is no blocking and] where sheathing is not suitable for direct nailing.
- .3 Align and plumb faces of furring and blocking to tolerance of 1:600.
- .4 Install wood fascia backing, nailers, curbs, roof spacers and other wood supports for roofing and sheet metal work, insulation, blocking, as indicated.
- .5 Secure with galvanized nails. Locate fastenings within 300 mm from ends and uniformly spaced between. Space nails at 200 mm centres except where indicated otherwise.

3.7 ROUGH BUCKS, NAILERS

- .1 Install rough bucks, nailers and linings to rough openings as required to provide backing for frames and other work.
- .2 Install wood cants, fascia backing, nailers, curbs and other wood supports as required and secure using steel fasteners.
- .3 Install sleepers as indicated.
- .4 Except where indicated otherwise use material at least 38 mm thick secured with 9 mm bolts located within 300 mm from ends of members and uniformly spaced at 1200 mm between.
- .5 Countersink bolts where necessary to provide clearance for other work.

3.3 ERECTION

- .1 Countersink bolts where necessary to provide clearance for other work.
- .2 Use nailing disks for soft sheathing as recommended by sheathing manufacturer.

- .3 Install dampproofing membrane between sole plate of stud walls set on slabs on grade and foundations, 300 mm wide, continuous with 200 mm laps, turned up inside, down on outside of wall, stamped in place both sides to studs, lapped over a vapour barrier where such is applied.
- .4 Obtain permission from Building Inspector of local authority having jurisdiction, before covering fire stop bridging with other materials.
- .5 Limit all other vertically continuous stud spaces exceeding 3 m in height by installing horizontal fire stop bridging of same size as studs at strategic points between studs.
- .6 Install horizontal fire stop bridge of same material as studs, between all studs at springing points of ceiling, where studs wall spaces extend continuously beyond edge of ceiling, and as detailed.
- .7 Use dust collectors and high quality respirator masks when cutting or sanding wood panels.

3.4 ROOF SHEATHING

- .1 Install roof sheathing in accordance with requirements of NBC.
- .2 Install roof plywood sheathing across wood trusses, rafters and joists.
- .3 Nail securely to joists, rafters, trusses, blocking. Use approved H clips at horizontal joints where no solid blocking under.
- .4 Stagger vertical joints of sheathing.
- .5 Leave smooth and securely fastened ready to receive shingles on sloped roof.

3.5 WALL SHEATHING

- .1 Install wall sheathing in accordance with manufacturer's printed instructions.
- .2 Apply plywood sheathing to walls. Nail securely to studs, plates, blocking and framing.
- .3 Cut sheathing neatly at door, window framed openings.
- .4 Leave smooth and securely fastened ready to receive sheathing paper and finishes.

3.6 SUBFLOORING

- .1 Install subflooring and combined subfloor and underlay with panel end-joints located on solid bearing, staggered at least 800 mm.
- .2 In addition to mechanical fasteners, floor panels secure floor subflooring to floor joists using glue and screws. Place continuous adhesive bead in accordance with manufacturer's instructions, single-bead on each joist and double-bead on joists where panel ends butt.

- .3 Install and layer T & G fir plywood subflooring using countersunk F.H. screws and continuous bead of adhesive on every joist and bearing member. Ensure smooth finish to receive carpet and resilient flooring. Use only "Select Tight Face" only.
- .4 Cut neatly to openings. All subflooring joints on solid blocking. Stagger joints.
- .5 Leave smooth and ready to receive toppings and floorings.
- .6 Install 3 mm thick poplar ply underlayment in all resilient floor areas.

3.7 SURFACE-APPLIED WOOD PRESERVATIVE

- .1 Treat surfaces of material with wood preservative, before installation. Wherever possible, apply preservative after materials have been cut and fit to size.
- .2 Apply preservative by dipping, or by brush or spray to completely saturate and maintain wet film on surface for minimum 3 minute soak on lumber and one minute soak on plywood.
- .3 Re-treat surfaces exposed by cutting, trimming or boring with liberal brush application of preservative before installation.
- .4 Treat all material as follows:
 - .1 Wood fascia backing, curbs, nailers, on roof deck.
 - .2 Wood in contact with exterior concrete walls.
 - .3 All exposed exterior wood framing.
 - .4 Wood in contact with grade (ie support for crawl space smoke separations).

3.8 Rejection of Defective Work

- .1 Where, in the opinion of the Departmental Representative, material or workmanship fails to meet the requirements of the specification, such work may be rejected. Work rejected shall be replaced or repaired to the approval of the Departmental Representative and at no additional cost to the Owner.
- .2 Where, in the opinion of the Departmental Representative, the finished appearance fails to meet the requirements of the specification, such work may be rejected. Work rejected shall be replaced to the approval of the Departmental Representative at no additional cost to the Owner. In the event of a discrepancy between the two above mentioned samples, the on-site sample retained by the Contractor shall govern.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 03 30 00 – Cast-in-Place Concrete
- .2 Section 07 21 16 – Fibrous Insulation
- .3 Section 07 27 13 – Modified Bituminous Air and Vapour Barrier
- .4 Section 07 27 19 – Sheet Membrane Air and Vapour Barrier
- .5 Section 07 61 00 – Sheet Metal Roofing
- .6 Section 09 21 16 – Gypsum Board Assemblies

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A653/A653M-15e1, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM C208-12, Specification for Cellulosic Fiber Insulating Board.
 - .3 ASTM C591-16, Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
 - .4 ASTM C612-14, Standard Specification for Mineral Fibre Block and Board Thermal Insulation.
 - .5 ASTM C726-17, Standard Specification for Mineral Wool Roof Insulation Board.
 - .6 ASTM C728-17, Standard Specification for Perlite Thermal Insulation Board.
 - .7 ASTM C1126-15, Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation.
 - .8 ASTM C1289-16, Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
 - .9 ASTM D1621-16, Standard Test Methods for Compressive Properties of Rigid Cellular Plastics.
 - .10 ASTM D2842-12, Standard Test Methods for Water Absorption of Rigid Cellular Plastics.
 - .11 ASTM E96/E96M-16, Standard Test Methods for Water Vapour Transmission of Materials.
- .2 American Society of Heating Refrigeration and Air-Conditioning (ASHRAE)
 - .1 ASHRAE 90.1-2013, Energy Standard for Buildings Except Low-rise Residential Buildings.
- .3 Canadian Gas Association (CGA)
 - .1 CAN/CGA-B149.1-15, Natural Gas and Propane Installation Code, Includes Update No.1 (2010).
 - .2 CAN/CGA-B149.2-15, Propane Storage and Handling Code.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

- .5 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-11, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S114-05, Test for Determination of Non-Combustibility in Building Materials.
 - .3 CAN/ULC-S604-M91, Standard for Factory-Built Type A Chimneys.
 - .4 CAN/ULC-S701-11, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Coverings.
 - .5 CAN/ULC-S702-.2-15, Mineral Fibre Thermal Insulation for Buildings, Part 2: Application Guidelines.
 - .6 CAN/ULC-S704-11, Standard for Thermal Insulation, Polyurethane and Polyisocyanurate Boards, Faced.

1.3 PRE-INSTALLATION MEETINGS

- .1 Pre-Installation Meetings: convene pre-installation meeting one week prior to beginning work of this Section and on-site installation, with contractor's representative and Departmental Representative in accordance with Section 01 31 19 – Project Meetings to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions.

1.4 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittals:
 - .1 Submit manufacturer's printed product literature, specifications and data sheet.
 - .2 Provide two copies of WHMIS MSDS - Material Safety Data Sheets in accordance with WHMIS acceptable to Labour Canada, and Health and Welfare Canada. Indicate VOC's insulation products and adhesives.
- .2 Manufacturer's Instructions:
 - .1 Submit manufacturer's installation instructions.

1.5 QUALITY ASSURANCE

- .1 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .3 Health and Safety Requirements: in accordance with Section 01 35 29 - Health and Safety Requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Storage and Handling Requirements:

- .1 Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- .2 Protect plastic insulation as follows:
 - .1 Do not expose to sunlight, except to extent necessary for period of installation and concealment.
 - .2 Protect against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.
 - .3 Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.7 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section - 01 74 21 Waste Management and Disposal.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturers: Subject to compliance with requirements specified in this section and as established by the Basis-of-Design materials, manufacturers offering similar products that may be incorporated into the Work include the following:
 - .1 Beaver Plastics
 - .2 Dow Canada
 - .3 Fibrex Insulations, Inc.
 - .4 Johns Manville
 - .5 Owens-Corning Canada
 - .6 Rockwool Inc.

2.2 INSULATION MATERIALS

- .1 Fibrous Mineral Wall Insulation: Unfaced, preformed rigid fibrous mineral slag board insulation in accordance with CAN/ULC S702 and as follows:
 - .1 Type: 1
 - .2 Thermal Resistance: RSI 0.76/25 mm minimum.
 - .3 Combustion Characteristics: non-combustible in accordance with CAN/ULC S114.
 - .4 Flamespread: less than 25 in accordance with CAN/ULC S102.
 - .5 Density: 72 kg/m³.
 - .6 Edges: square.
 - .7 Size: 406 mm x 1220 mm x thickness as indicated on Drawings.
 - .8 Acceptable Materials:
 - .1 Fibrex, CWB 45.
 - .2 Rockwool, CavityRock.
 - .3 Owens Corning Canada LP, Series 705

2.3 ACCESSORIES

- .1 Thermal Spacers: low-conductivity, fibreglass thermal spacers as follows:
 - .1 Depth: 150 mm and as indicated on Drawings.
 - .2 Spacing: as indicated on Drawings or as required to suit conditions.
 - .3 Fasteners: as recommended by manufacturer in length to suit wall construction.
 - .4 Acceptable Materials:
 - .1 Cascadia Clip, by Cascadia Windows Ltd.
 - .2 ISO Clip, Northern Facades
- .2 Insulation Fasteners
 - .1 Mechanical Fasteners: High quality, impact resistant plastic fastener system specifically designed for installation of board insulation materials; 38 mm diameter, shaft length to suit insulation thickness and hot dipped galvanized fastener to suit substrate, and as follows:
 - .1 Basis-of-Design Materials:
 - .1 Ucan Fastening Systems, Insulation Fasteners
 - .2 Insulation Clips: Impale type, perforated 50 mm x 50 mm cold rolled carbon steel 0.912 mm core metal thickness, adhesive back; 2.657 mm diameter annealed steel wire spindle, length to suit insulation, 25 mm diameter self locking washers, and as follows:
 - .1 Basis-of-Design Materials: [Gemco Insulation Fasteners](#), Insulation Hanger; substitutions will be considered for this material.
- .3 **Perimeter Insulation Flashings**: Coordinate supply of end closures and flashings for perimeter insulation system with Section 07 62 00.
- .4 **Drainage board**: high-strength drainage panel consisting of polypropylene core and fabric for installation over waterproof membranes with the following characteristics:
 - .1 Thickness: 10 mm
 - .2 Compressive strength: 550 kPa
 - .3 Flow rate: 223 l/min/m.
 - .4 Acceptable materials:
 - .1 DB 2000, Bakor.
 - .2 Mel-Drain 5035, W.R. Meadows.
 - .3 Sopradrain 10G, Soprema.
- .5 Sheet steel: liner sheet, structural quality, grade A to ASTM A653, with Z275 zinc coating:
 - .1 Light duty modified silicone finish.
 - .2 Dry film thickness: 0.025 mm.
 - .3 Colour: White.
 - .4 Thickness: 0.45 mm.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.2 EXAMINATION

- .1 Examine substrates and immediately inform Departmental Representative in writing of defects.
- .2 Prior to commencement of work ensure:
 - .1 Substrates are firm, straight, smooth, dry, free of snow, ice or frost, and clean of dust and debris.

3.3 WORKMANSHIP

- .1 Install insulation after building substrate materials are dry.
- .2 Install insulation to maintain continuity of thermal protection to building elements and spaces.
- .3 Fit insulation tight around electrical boxes, plumbing and heating pipes and ducts, around exterior doors and windows and other protrusions.
- .4 Keep insulation minimum 75 mm from heat emitting devices such as recessed light fixtures, and minimum 50 mm from sidewalls of CAN4-S604 type A chimneys and CAN/CGA-B149.1 and CAN/CGA-B149.2 type B and L vents.
- .5 Use only insulation boards free from chipped or broken edges that is dry, and unsoiled and that has not been left exposed at any time to ice and snow.
- .6 Use largest possible dimensions to reduce number of joints.
- .7 Offset both vertical and horizontal joints in multiple layer applications.
- .8 Do not enclose insulation until it has been reviewed by Departmental Representative.

3.4 INSTALLATION: GENERAL

- .1 Install rigid insulation to maintain continuous thermal insulation, vapour barrier and air tightness for building spaces and elements.
- .2 Saw-cut and trim insulation neatly to fit spaces. Butt edges and ends tight. Fit insulation tight against mechanical, electrical and other items protruding plane of insulation. Fill voids with foamed-in-place insulation compatible with installed insulation; refer to Section 07 21 19.
- .3 Follow the instructions for use of materials of insulation and accessory manufacturers.
- .4 Install insulation horizontally. Offset vertical joints minimum 300 mm.
- .5 Leave insulation joints unbonded over line of expansion and control joints; bond a continuous 150 mm wide strip of primary vapour membrane over expansion and control joints using compatible adhesive.

3.5 INSTALLATION: PERIMETER INSULATION

- .1 Install board insulation to vertical surfaces with adhesive applied in accordance with manufacturer's written instructions, and as follows:
 - .1 Exterior Application: Extend boards as indicated on Drawings, installed on exterior face of perimeter foundation wall.
 - .2 Apply adhesive to the substrate by the "dab" method not less than 10 mm x 20 mm size at 150 mm centres; bed the insulation in the adhesive before the adhesive loses its tack or skins over.
 - .3 Protect below grade insulation on vertical surfaces from damage during backfilling by applying protection board; set in adhesive according to insulation manufacturer's written instructions.

3.6 INSTALLATION: CAVITY WALL INSULATION

- .1 Cavity Wall Insulation: Fit courses of insulation between wall ties and other confining obstructions in cavity; butt edges tightly in vertical and horizontal directions and as follows:
 - .1 Install cavity insulation with a tight fit to substrate materials, provide adhesive and additional fasteners where uneven substrates cause air spaces behind insulation; apply adhesive to substrate in a continuous film not less than 3 mm thick when wet and bed the insulation into adhesive before adhesive loses its tack or skins-over.
 - .2 Apply insulation fasteners using a minimum of six (6) fasteners in two rows located near the centre of the board along the narrow dimension and near the third points along the long dimension; secure boards with two clips at the centre where both dimensions are less than 600 mm.
 - .3 Apply sheet membrane vapour retarder behind Z-bars prior to installation of insulation between Z-bars supporting preformed metal cladding.
 - .4 Install insulation clips to walls before sheet membrane vapour retarders are applied.

3.7 CLEANING AND PROTECTION

- .1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.
- .2 Protect installed board insulation from damage due to harmful weather exposures, physical abuse, and other causes.
- .3 Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 06 10 00 – Rough Carpentry
- .2 Section 07 21 13 – Board Insulation
- .3 Section 07 27 13 – Modified Bituminous Air and Vapour Barrier
- .4 Section 07 27 19 – Sheet Membrane Air and Vapour Barrier
- .5 Section 09 21 16 – Gypsum Board Assemblies
- .6 Section 09 22 00 – Non-Structural Metal Framing

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM C167-15, Standard Test Methods for Thickness and Density of Blanket or Batt Thermal Insulations.
 - .2 ASTM C553-13, Specification for Mineral Fibre Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .3 ASTM C665-12, Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
 - .4 ASTM C1320-10 (2016), Standard Practice for Installation of Mineral Fiber Batt and Blanket Thermal Insulation for Light Frame Construction.
 - .5 ASTM C520-15, Standard Test for Density of Granular Loose Fill Insulations.
 - .6 ASTM C1015-17, Standard Practice for Installation of Cellulosic and Mineral Fiber Loose-Fill Thermal Insulation.
 - .7 ASTM C1630-11 (2016), Standard Guide for Development of Coverage charts for Loose-Fill Thermal Building Insulations.
 - .8 ASTM F1667-17, Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.
- .2 Canadian Gas Association (CGA)
 - .1 CAN/CSA-B149.1-15, Natural Gas and Propane Installation Code, Includes Update No. 1 (2010).
 - .2 CAN/CGA-B149.2-15, Propane Storage and Handling Code.
- .3 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-11, Standard Method of Test For Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S114-05, Standard Method of Test for Determination of Non-Combustibility in Building Materials.
 - .3 CAN/ULC-S604-2016, Standard for Factory Built Type A Chimneys.
 - .4 CAN/ULC-S702.2-15, Mineral Fibre Thermal Insulation for Buildings, Part 2: Application Guidelines.

1.3 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittals:

- .1 Submit manufacturer's printed product literature, specifications and data sheet.
- .2 Submit WHMIS MSDS - Material Safety Data Sheets. WHMIS MSDS acceptable to Labour Canada and Health and Welfare Canada for sealants. Indicate VOC content.
- .2 Manufacturer's Instructions:
 - .1 Submit manufacturer's installation instructions.

1.4 QUALITY ASSURANCE

- .1 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver insulation and accessories in original unopened packaging or cartons bearing manufacturer's seals and labels.
- .2 Store materials under cover on raised platforms, away from moisture. Keep dry at all times.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Waste Management and Disposal.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturers: Subject to compliance with requirements specified in this section and as established by the Basis-of-Design materials, manufacturers offering similar products that may be incorporated into the Work include the following:
 - .1 CertainTeed Corporation
 - .2 Johns-Manville Corporation
 - .3 Knauf Insulation
 - .4 Owens-Corning Canada LP.
 - .5 Rockwool Inc.

2.2 BATT INSULATION

- .1 Fibrous Glass Acoustical Insulation For Non-rated Assemblies: Un-faced, preformed GreenGuard™ or formaldehyde free binder fibrous insulation meeting the requirements of ASTM C423, ASTM E90, ASTM E413 and ULC S702 and as follows:
 - .1 Type: 1
 - .2 Width: to friction fit in stud spaces.

- .3 Thickness: to fill a minimum of 90% of the cavity thickness.
- .4 STC Ratings: as indicated on Drawings
- .5 Acceptable materials:
 - .1 Johns Manville, Sound Shield Glass Fibre Batts.
 - .2 Owen-Corning Canada LP., Ecotouch Quietzone Pink Fiberglass Acoustic Insulation.
- .2 Mineral Fibre Insulation For Fire and Smoke Rated Assemblies: Un-faced preformed GreenGuard™ or formaldehyde free binder fibrous insulation meeting the requirements of ULC S702; having maximum flame spread and smoke developed of 20/20 in accordance with CAN/ULC S102 and being non-combustible in accordance with CAN/ULC S114 and as follows:
 - .1 Type: 1.
 - .2 Width: to friction fit in stud spaces.
 - .3 Thickness: minimum 89 mm to fill a minimum of 90% of the cavity thickness.
 - .4 STC Ratings: as indicated on Drawings.
 - .5 Acceptable materials:
 - .1 Owens-Corning Canada LP., Ecotouch Quietzone Pink FiberGlas Acoustic Insulation.
 - .2 Rockwool Inc., Roxul AFB Acoustical Fire Batt.
- .3 Refer to Section 09 21 16 – Gypsum Board Assemblies for insulation in interior partitions.

2.3 ACCESSORIES

- .1 Insulation clips:
 - .1 Impale type, perforated 50 x 50 mm cold rolled carbon steel 0.8 mm thick, adhesive back, spindle of 2.5 mm diameter annealed steel, length to suit insulation, 25 mm diameter washers of self locking type.
- .2 Nails: galvanized steel, length to suit insulation plus 25 mm, to ASTM F1667.
- .3 Staples: 12 mm minimum leg.
- .4 Tape: as recommended by manufacturer.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.2 PREPARATION

- .1 Verify all in-wall construction is complete before beginning installation.
- .2 Install insulation after building substrate materials are dry.

- .3 Ensure substrate materials are properly installed and complete before beginning installation.

3.3 INSTALLATION

- .1 Install batts between framing members, structural components and other items snug and tight.
- .2 Cut and trim batts neatly to fit spaces. Use batts free from ripped or damaged back and edges.
- .3 Do not compress insulation to fit into spaces.
- .4 Install batt insulation where indicated with continuous vapour retarder on the warm side of the insulation in accordance with ASTM C1320.
- .5 Fit insulation closely around electrical boxes, pipes, ducts, frames and other objects in or passing through insulation.
- .6 Keep insulation minimum 75 mm from heat emitting devices such as recessed light fixtures, and minimum 50 mm from sidewalls of CAN/ULC-S604 Type A chimneys and CAN/CGA-B149.1 and CAN/CGA-B149.2 Type B and L vents.
- .7 Fill stud space of exterior framed walls with insulation full depth of stud only where no insulation/vapour retardant indicated on exterior face of stud walls.
- .8 Hold insulation in position with clips, wires or as recommended by manufacturer when insulation is installed in horizontal locations.
- .9 Do not enclose insulation until it has been reviewed by Departmental Representative.

3.4 CLEANING

- .1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

Part 1 General

1.1 INTENT

- .1 Foam-in-place insulation to exterior hollow steel door frames, aluminum door frames and window frames.
- .2 Foam-in-place insulation around protrusions through the exterior wall envelope and juncture of different cladding materials.

1.2 RELATED SECTIONS

- .1 Section 07 21 13 – Board Insulation
- .2 Section 07 21 16 – Fibrous Insulation
- .3 Section 07 27 13 – Modified Bituminous Air and Vapour Barrier
- .4 Section 07 92 00 – Sealants
- .5 Section 08 11 13 – Steel Doors and Frames
- .6 Section 08 11 16 – Aluminum Doors and Frames

1.3 REFERENCES

- .1 Canadian Urethane Foam Contractors' Association Inc. (CUFCA)
- .2 Green Seal Environmental Standards
 - .1 Standard GC-03-97, Anti-Corrosive Paints.
 - .2 Standard GS-11-10, Paints and Coatings.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .4 South Coast Air Quality Management District (SCAQMD), California State SCAQMD Rule 1113-06, Architectural Coatings.
- .5 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S101-07, Standard Methods of Fire Endurance Tests of Building Construction and Materials.
 - .2 CAN/ULC-S102-11, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
 - .3 CAN/ULC-S705.1-15, Standard for Thermal Insulation - Spray Applied Rigid Polyurethane Foam, Medium Density,-Material –Specification.
 - .4 CAN/ULC-S705.2-05, Standard for Thermal Insulation - Spray Applied Rigid Polyurethane Foam, Medium Density, Application.

1.4 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittals:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Provide two copies of WHMIS MSDS - Material Safety Data Sheets in accordance with WHMIS acceptable to Labour Canada, and Health and Welfare Canada.

- .2 Quality assurance submittals: submit following in accordance with Section 01 45 00 - Quality Control.
 - .1 Test reports: submit certified test reports for insulation from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.
 - .2 Submit test reports in accordance with CAN/ULC-S101 for fire endurance and CAN/ULC-S102 for surface burning characteristics.
 - .3 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, and cleaning procedures.

1.5 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Installers: Use companies that are members and licensed CUFCA having trained and certified installers in accordance with CAN/ULC S705.2 and CUFCA requirements.
 - .2 Manufacturer: Obtain air and vapour seal materials from a single manufacturer regularly engaged in manufacturing the products specified in this Section.
- .2 Cooperate and coordinate with the requirements of other units of work specified in other sections.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

1.7 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Waste Management and Disposal.

1.8 SITE CONDITIONS

- .1 Protect adjacent surfaces and equipment from damage by overspray, fall-out, and dusting of insulation materials.
- .2 Apply insulation only when surfaces and ambient temperatures are within manufacturers' prescribed limits.
- .3 Ensure temperature is maintained throughout the curing period.

Part 2 Products

2.1 MATERIALS

- .1 Insulation: Closed cell, two pound density, one component rigid urethane foam.
 - .1 Acceptable Materials:

- .1 CF128-CW, Hilti (Canada) Ltd.
 - .2 EnerFoam, Abisko Manufacturing Inc.
 - .3 Froth Pak, Dow Chemical Co.
 - .4 Handi-seal Window & Door Sealant, Fomo Products Inc.
 - .5 RHH Foam Systems Inc.
- .2 Thermal Barrier: spray applied fire retardant overcoat meeting applicable requirements of the Building Code for thermal barrier of foamed plastic.
 - .1 Acceptable Material:
 - .1 A/D Thermal Barrier, AD Fire Protection Systems.
 - .2 CafcoBlaze-Shield II, Isolatek International
 - .3 Monokote Z-3306, WR Grace & Co.

Part 3 Execution

3.1 SURFACE PREPARATION/EXISTING CONDITIONS

- .1 Clean spaces that are to receive insulation, of dirt, dust, grease, loose material or other foreign matter that may inhibit adhesion.
- .2 Provide sufficient ventilation during and until insulation has cured, to ensure safe working conditions. Introduce fresh air and exhaust air continuously during the 24 hour period after application.
- .3 Protect adjacent surfaces from overspray and dusting.
- .4 Prior to application, slightly moisten surfaces to which foam in place insulation is being applied, to accelerate curing.
- .5 Temporarily brace frames as may be required to prevent possible bowing of frames due to over expansion of the foam-in-place insulation.

3.2 INSTALLATION/AIR SEAL AROUND EXTERIOR WINDOW AND DOOR FRAMES

- .1 Fill exterior hollow steel door frames 75% full with foam-in-place insulation prior to installation of frames. Fill the remainder of the frame after installation, through the gap between the frame and the wall construction.
- .2 Install foam-in-place insulation around all exterior window frames to maintain continuity of the thermal barrier, after air barrier has been installed and sealed to windows as specified.
- .3 Ensure that foam completely fills spaces, without voids, and that foam is continuous at corners.

3.3 INSTALLATION/AROUND PROTRUSIONS THROUGH AIR SEAL

- .1 Install foam-in-place insulation around all protrusions through the exterior building envelope to achieve and maintain continuity of air/vapour seal.

3.4 CLEANING

- .1 Cut back excess foam-in-place insulation once cured, flush with surrounding surfaces, or recess back for application of sealant as specified in Section 07 92 00.
- .2 Upon completion of foam-in-place insulation work, clean adjacent surfaces of overspray and dusting to the satisfaction of the Departmental Representative.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 03 30 00 – Cast-In-Place Concrete
- .2 Section 07 21 13 – Board Insulation
- .3 Section 07 21 16 – Fibrous Insulation
- .4 Section 07 21 19 – Foam-In-Place Insulation
- .5 Section 07 61 00 – Sheet Metal Roofing
- .6 Section 07 92 00 – Sealants
- .7 Section 08 11 14 – Steel Doors and Frames
- .8 Section 08 11 16 – Aluminum Doors and Frames
- .9 Section 09 21 16 – Gypsum Board Assemblies

1.2 REFERENCES

- .1 American Society for Testing of Materials (ASTM)
 - .1 ASTM D93-16a, Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester.
 - .2 ASTM D146/D146M-04 (2012) e1, Standard Test Methods for Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing.
 - .3 ASTM D412-16, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension.
 - .4 ASTM D1970-16, Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.
 - .5 ASTM E96/E96M-16, Standard Test Methods for Water Vapor Transmission of Materials.
 - .6 ASTM E283-04 (2012), Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
 - .7 ASTM E2178-13, Standard Test Method for Air Permeance of Building Materials.
 - .8 ASTM E2357-11, Standard Test Method for Determining Air Leakage of Air Barrier Assemblies.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-51.34-M86, Vapour Barrier, Polyethylene Sheet for Use in Building Construction.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Coordination:
 - .1 Select products to be compatible with adjoining membranes previously installed under related Sections

- .2 Select products from a single manufacturer, or products which are compatible from different manufacturers.
 - .3 Coordination between all installers of each component of vapour and air retarder system is essential to ensure continuity of system and that junctions between the various components are effectively sealed.
 - .4 Verify with manufacturers and all tradesmen involved with installation procedures of building products incorporated into air barrier elements including, but not limited to, various membranes, coating and sealants as well as continuity with roofing membrane.
- .2 Pre-installation Meeting:
- .1 Convene one (1) week before commencing Work of this Section.
 - .2 Arrange for manufacturer's factory-trained agent to be on site at beginning of installation to provide training and supervision of personnel who will install membrane. Agent shall also provide frequent inspection visits thereafter to assure quality and competence of membrane installations.
- .3 Sequencing:
- .1 Sequence work in accordance with Construction Progress Schedule.
 - .2 Sequence work to permit installation of materials in conjunction with related materials and seals.

1.4 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittals Procedures.
- .1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit WHMIS MSDS - Material Safety Data.
 - .3 Submit statement from manufacturer(s), indicating products supplied under this Section are compatible with one another and with products previously installed under the work of related Sections.
- .2 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
- .1 Provide duplicate 200 mm x 200 mm samples of membrane adhered to all project substrates, including adjoining membranes specified in other Sections.
- .3 Quality Assurance Submittals: submit following in accordance with Section 01 45 00 - Quality Control.
- .1 Existing Substrate Condition: report deviations, as described in PART 3 - EXAMINATION in writing to Departmental Representative.
 - .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .3 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, cleaning procedures.

1.5 QUALITY ASSURANCE

- .1 Applicator: company specializing in performing work of this section with experience with installation of air/vapour barrier systems.
 - .1 Completed installation must be approved by the material manufacturer.
- .2 Applicator: company:
 - .1 Currently licensed by National Air Barrier Association certifying organization.
 - .2 Must maintain their license throughout the duration of the project.
- .3 Single-Source Responsibility: obtain primary air and vapour materials from a single manufacturer regularly engaged in the manufacturing and supply of the specified products and meeting or exceeding the material properties and performance characteristics of the materials and manufacturers named in this Section.

1.6 MOCK-UP

- .1 Construct mock-up in accordance with Section 01 45 00 - Quality Control.
- .2 Construct typical exterior wall panel, 3 m long by 4 m wide, incorporating window and frame and sill, insulation, building corner condition, and junction with roof system; illustrating materials interface and seals.
- .3 Locate where directed.
- .4 Mock-up may remain as part of finished work.
- .5 Allow review of mock-up by Departmental Representative before proceeding with air/vapour barrier Work. Accepted mock-up will demonstrate minimum standard of quality required for this project.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

1.8 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

1.9 AMBIENT CONDITIONS

- .1 Install solvent curing sealants and vapour release adhesive materials in open spaces with ventilation.
- .2 Ventilate enclosed spaces in accordance with Section 01 51 00 - Temporary Utilities.
- .3 Maintain temperature and humidity recommended by materials manufacturer before, during and after installation.

- .4 Apply air/vapour barrier membrane to gypsum board surfaces which are dry, when temperature is 4 degrees C or higher or as per manufacturers recommendations.
- .5 Apply air/vapour barrier membrane to cast-in-place concrete, precast concrete, masonry (strike masonry joints flush) which are smooth, clean, dry, and in good condition. Moisture, grease, machine oil or other foreign material must be removed. Concrete must be cured, minimum 7 days, and dry before application, and when temperature is 5 degrees C or higher or as per manufacturers recommendations.

1.10 WARRANTY

- .1 Manufacturer's Warranty: issue and written and signed warranty in the name of the Owner, certifying the product will meet the physical characteristics published by the manufacturer for a period of 5 years starting from the completion date of installation of membranes.
- .2 Installer's Warranty: Submit installers warranty stating that air and vapour membranes and accessories are installed in accordance with manufacturer's recommendation and that membrane, transitions and through-wall flashing membranes, primers, mastics, adhesives and sealants are sourced from one manufacturer.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturers: Subject to compliance with requirements specified in this section and as established by the Basis-of-Design materials, manufacturers offering similar products that may be incorporated into the Work include the following:
 - .1 Bakor Inc. (Henry Canada)
 - .2 Grace Construction Materials
 - .3 IKO Industries Ltd.
 - .4 Protecto Wrap
 - .5 Soprema Canada
 - .6 Tremco Commercial Sealants and Waterproofing
 - .7 W.R. Meadows Inc.

2.2 SELF-ADHESIVE AIR AND VAPOUR BARRIER SYSTEM MATERIALS

- .1 Primer: SBS synthetic rubbers, adhesive resins and solvents used to prime porous substrates to enhance adhesion of self-adhesive membranes at temperatures above -10°C.
 - .1 Specific gravity at 20°C (kg/l): 0.79 to 1.0 kg/l
 - .2 Solids by weight: 24% to 53%
 - .3 Flash point: -30°C to ASTM D93
 - .4 Acceptable materials:
 - .1 Elastocol Stick, Soprema

- .2 SAM Adhesive, IKO
- .3 Mel-Prime WB, W.R. Meadows
- .4 Aquatac Primer, Henry Bakor
- .1 Blueskin Adhesive, Henry Bakor.
- .2 IKO SAM LVC
- .3 Hi-Tac Adhesive, Henry Bakor
- .4 Perm-A-Barrier Adhesive, GCP Applied Technologies
- .5 AquaBarrier Primer, IKO
- .6 Exoair Primer #10, Tremco Inc
- .7 Mel-Prime SB, W.R. Meadows
- .2 Air/Vapour Barrier Membrane (winter application): to CAN/CGSB 37.56 or ASTM D1970; SBS modified bitumen, self-adhering sheet membrane with polyethylene facer, for application temperatures between -10°C and 10°C and as follows:
 - .1 Thickness: 1 mm to 1.5 mm
 - .2 Tensile strength: 11.3 kN/m to 15.4 kN/m to ASTM D5147.
 - .3 Ultimate elongation: 25% to 40%
 - .4 Flexibility at cold temperature: minimum -30°C
 - .5 Air permeability: <0.0003 L/sec. m²
 - .6 Water vapour permeability: <0.05 perm
 - .7 Static puncture: minimum 178 N
 - .8 Lap adhesion: 800 N/m
 - .9 Acceptable materials:
 - .1 Blueskin SALT, Henry Bakor
 - .2 CCW-705LT, Carlisle
 - .3 Perm-A-Barrier Wall Membrane LT, GCP Applied Technologies
 - .4 Sopraseal Stick 1100 T, Soprema.
 - .5 AVB LT, IKO
 - .6 Exoair 110 LT, Tremco Inc.
 - .7 Air Shield LT, W.R. Meadows.
- .3 Air/Vapour Barrier Membrane (summer application): to CAN/CGSB 37.56 or ASTM D1970; SBS modified bitumen, self-adhering sheet membrane with polyethylene facer, for application temperature above 5°C, and as follows:
 - .1 Thickness: 1 mm to 1.5 mm
 - .2 Tensile strength: minimum 6 kN/m
 - .3 Ultimate elongation: 25% to 40%
 - .4 Flexibility at cold temperature: minimum -17°C
 - .5 Air permeability: <0.0003 L/sec. m²
 - .6 Water vapour permeability: <0.05 perm
 - .7 Static puncture: 400 N
 - .8 Lap adhesion: minimum 1750 N/m
 - .9 Acceptable materials:

- .1 Blueskin SA, Bakor.
- .2 Perm-A-Barrier Wall Membrane, GCP Applied Technologies
- .3 AquaBarrier AVB, IKO.
- .4 Sopraseal Stick 1100, Soprema.
- .5 AVB LT, IKO
- .6 Exoair 110, Tremco Inc.
- .7 Air Shield, W.R. Meadows.

2.3 MASTICS AND ADHESIVES

- .1 Waterproofing Mastic: solvent-based mastic containing SBS modified bitumen, fibres and mineral fillers, used to seal around penetrations and extrusions.
 - .1 Compatibility: With air/vapour barrier membrane, substrate and insulation.
 - .2 Specific gravity at 20°C: 1.0 kg/l to 1.12 kg/l
 - .3 Application Temperature: -10°C to +35°C
 - .4 Solids by Weight: 70% to 83 %
 - .5 Acceptable materials:
 - .1 Bituthene Mastic, GCP Applied Technologies
 - .2 Air-Bloc 21 or Air-Bloc 230-21 Adhesive, Henry Bakor.
 - .3 570-05 Polybitume Henry Bakor
 - .4 925 BES Sealant Henry Bakor
 - .5 Exoair Termination Mastic, Tremco Inc.
 - .6 AquaBarrier Mastic, IKO.
 - .7 Sopreamastic, Soprema.
 - .8 Pointing Mastic, W.R. Meadows.

2.4 ACCESSORIES

- .1 Thinner and cleaner for Butyl or Neoprene Sheet: as recommended by sheet material manufacturer.
- .2 Attachments: galvanized steel bars and anchors.
- .3 Roof-to-Wall Transition Membranes: Manufacturer's recommended reinforced self adhesive, compatible with roofing air and vapour membranes and wall materials specified in this Section.
 - .1 Acceptable Materials:
 - .1 Henry Blueskin Butyl Flash for transition with EPDM, PVC and TPO Membranes.
- .4 Through Wall Membranes: Manufacturer's recommended reinforced self adhesive, compatible with air and vapour membrane and that will not become plastic and extrude onto finished surfaces when exposed to high wall temperatures.
 - .1 Acceptable Materials:
 - .1 Blueskin TWF, Henry Bakor
 - .2 TWF, IKO

.3 Sopraseal WFM, Soprema

- .5 Masonry Flashing Membrane: self-adhesive membrane as recommended by membrane manufacturer and composed of thermoplastic polymer modified bitumen and a high density polyethylene film with a silicone release film on the lower surface.
- .6 Butyl Adhesive: provide butyl based adhesive membrane for locations in contact with plasticized vinyl including, but not limited to, vinyl deck membranes.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 ENVIRONMENTAL REQUIREMENTS

- .1 All membrane shall be installed at surface and ambient temperature of 5°C or above, in dry weather conditions.
- .2 For applications below 5°C consult membrane manufacturer's technical representative for instructions and, obtain Departmental Representative's approval before proceeding with Work.
- .3 Self adhered membrane shall not be applied below application temperature of minus 10 °C despite primers being able to be applied at colder temperatures.

3.3 EXAMINATION AND PREPARATION

- .1 Verify that surfaces and conditions are ready to accept work of this section.
- .2 Ensure surfaces are clean, dry, sound, smooth, continuous and comply with air barrier manufacturer's requirements.
- .3 Remove loose or foreign matter, which might impair adhesion of materials.
- .4 Ensure substrates are clean of oil or excess dust; masonry joints struck flush, and open joints filled; and concrete surfaces free of large voids, spalled areas or sharp protrusions
- .5 Do not install materials during rain or snowfall.
- .6 Report unsatisfactory conditions to Departmental Representative in writing.
- .7 Do not start work until deficiencies have been corrected.
- .1 Beginning of Work implies acceptance of conditions.

3.4 INSTALLATION: SELF ADHERING SYSTEM

- .1 Apply primer to substrates in accordance with manufacturer's written instructions. Apply primer that will be covered with membrane the same day. Re-prime areas that are not covered the same day.
- .2 Align and position self-adhering transition membrane, remove protective film and press firmly into place. Ensure minimum 150 mm overlap at all end and side laps.

- .3 Corner details: Double cover outside and inside corners, use 300 mm wide initial strip of membrane centred on axis of corner. Follow with full width of sheet membrane to cover initial strip completely.
- .4 Construction and control joints: Install membrane in double thickness over properly sealed joints, use 300 mm wide initial strip of membrane centred over joint. Follow with full width of sheet membrane. Assure that joints are properly sealed; joint filler and a compatible sealant are installed
- .5 Tie-in to window frames, aluminium screens, hollow metal doorframes, spandrel panels, roofing system and at the interface of dissimilar materials as indicated in drawings.
- .6 Roll laps and membrane with a counter top roller to effect seal.
- .7 Small protrusions (pipes, etc.) through the waterproofing membrane, should be pre-stripped with a membrane and sealed with mastic
- .8 Inspect membrane installation meticulously and immediately. Holes and tears in the membrane must be repaired with air / vapour barrier membrane material. The repair must exceed the affected surface area by a minimum of 150 mm. The membrane piece applied for the repair must be sealed around its edges with mastic.

3.5 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.
- .2 The Departmental Representative shall inspect installed membrane for continuity of air barrier prior to placement of insulation.

3.6 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.7 PROTECTION OF WORK

- .1 Protect finished work from penetrations.
- .2 Do not permit adjacent work to damage work of this section.
- .3 Ensure finished work is protected from climatic conditions.
- .4 Repair to manufacturers written instructions.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 06 10 00 – Rough Carpentry
- .2 Section 07 27 13 – Modified Bituminous Air and Vapour Barrier
- .3 Section 09 21 16 – Gypsum Board Assemblies

1.2 REFERENCES

- .1 American Concrete Institute International (ACI):
 - .1 ACI 302.2R-06, Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E96/E96M-16, Standard Test Methods for Water Vapor Transmission of Materials.
 - .2 ASTM E154-08a(2013)e1, Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.
 - .3 ASTM E1643-11(2017), Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
 - .4 ASTM E1677-11, Standard Specification for an Air Barrier (AB) Material or System for Low-Rise Framed Building Walls.
 - .5 ASTM E1745-11, Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs.
 - .6 ASTM E2178-13, Standard Test Method for Air Permeance of Building Materials.
 - .7 ASTM E2357-11, Standard Test Method for Determining Air Leakage of Air Barrier Assemblies.
 - .8 ASTM F1249-13, Standard Test Method for Water Vapour Transmission Rate through Plastic Film and Sheeting Using a Modulated Infrared Sensor.
- .3 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB 51.32-M77, Sheathing, Membrane, Breather Type.
 - .2 CAN/CGSB-51.34-M86, Vapour Barrier, Polyethylene Sheet for Use in Building Construction.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Coordination:
 - .1 Coordination between all installers of each component of vapour and air retarder system is essential to ensure continuity of system and that junctions between the various components are effectively sealed.
 - .2 Verify with manufacturers and all tradesmen involved with installation procedures of building products incorporated into vapour and air retarder

elements including, but not limited to, various membranes, coatings and sealants as well as continuity with roofing membrane.

1.4 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittals Procedures.
 - .1 Submit manufacturer's printed product literature, specifications and data sheet for each product specified.
 - .2 Submit manufacturer's installation instructions including joint treatment recommendations.

1.5 MOCK-UP

- .1 Construct mock-up in accordance with Section 01 45 00 - Quality Control.
- .2 Construct typical exterior wall panel, 3 m long by 4 m wide, incorporating window openings with frame and sill installed, insulation, building corner condition, junction with roof system; illustrating materials interface and seals.
- .3 Locate where directed by Departmental Representative.
- .4 Mock-up may remain as part of Work.
- .5 Allow 24 hours for inspection of mock-up by Departmental Representative before proceeding with air/vapour barrier work.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Store materials in clean, dry area in accordance with manufacturer's instructions.
- .3 Protect materials during handling and application to prevent damage.

1.7 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for recycling in accordance with Section 01 74 21 - Waste Management and Disposal.

Part 2 Products

2.1 SHEET MATERIALS

- .1 Building Paper: Asphalt impregnated kraft paper manufactured from virgin cellulose and having a 30 minute moisture resistance rating meeting the requirements of CGSB 51.32.

2.2 AIR BARRIER SHEET MATERIALS

- .1 Self-Adhered Air Barrier Membrane: water resistive, vapour permeable, air barrier sheet membrane consisting of laminated modified polyolefin with two layers of non-woven polyethylene and adhesive backing to be protected with 3 piece release film. Tested to ASTM E2357 and as follows:
 - .1 Air Leakage: $< 0.02 \text{ L/s/m}^2 @ 75 \text{ Pa}$ in accordance with ASTM E2178.
 - .2 Vapour Permeance: 29 perms to ASTM E96, Dessicant method A.

- .3 Water Vapour Transmission Rate: 202 g/m² 24 hours maximum.
- .4 Acceptable Materials:
 - .1 Blueskin VP160, Henry Bakor.
 - .2 CCW 705, Carlisle remove PERM less than 10
 - .3 Perm-A-Barrier VPS, GCP Applied Technologies
 - .4 Wrapsheild SA, Vaproshield, LLC
 - .5 Other materials may be acceptable subject to compliance with requirements, provided information is provided to Departmental Representative for review and acceptance prior to Bid Closing. Only membranes with a minimum of 29 PERMS to ASTM E96 dessicant method A will be considered.
- .2 Primer: rubber based adhesive primer for self adhered air barrier
 - .1 Acceptable Materials:
 - .1 Perm-A-Barrier Adhesive, GCP Applied Technologies
 - .2 Blueskin Adhesive, Henry Bakor
 - .3 Blueskin LVC Adhesive, Henry Bakor
 - .4 Hi-Tac Adhesive, Henry Bakor
 - .5 Blueskin Spray Prep, Henry Bakor
 - .6 Aquatac Adhesive , Henry Bakor
- .3 Termination sealants as recommended by air barrier membrane manufacturer.
 - .1 Acceptable Materials:
 - .1 Bituthene Mastic, GCP Applied Technologies
 - .2 Henry 925 BES Sealant, Henry Bakor
 - .3 Koprlastic, Henry Bakor
 - .4 Other materials may be acceptable subject to compliance with requirements, provided information is provided to Departmental Representative for review and acceptance prior to Bid Closing.

2.3 VAPOUR BARRIER SHEET MATERIALS

- .1 Plastic Sheet Vapour Retarder (Exterior Stud Walls): 6 mil polyethylene sheet meeting requirements of CAN/CGSB-51.34.
- .2 Plastic Sheet Vapour Retarder (Underslab): High density, puncture resistant polyethylene sheet in accordance with ASTM E1745 and CAN/CGSB-51.34, and as follows:
 - .1 Thickness: 10 mil
 - .2 Vapour Permeance: Nominal ≤ 0.044 Perms maximum
 - .3 Tensile Strength and Puncture Resistance: ASTM E1745 Class B minimum
 - .4 Acceptable materials:
 - .1 Layfield Construction Materials, VaporFlex 10
 - .2 Raven Industries, VaporBlock VB 10
 - .3 Stego Industries LLC, Stego Wrap 10 mil
 - .4 W.R. Meadows, Perminator 10 mil

2.4 ACCESSORIES

- .1 Accessory Materials: Provide manufacturer's required seam tape, pipe boots and vapour proofing mastic forming a complete system in accordance with CAN/CSA A23.1 and ASTM E1643
- .2 Seam Tape: High density, air resistant polyethylene tape with pressure sensitive adhesive. Type as recommended by vapour retarder manufacturer. Minimum 100 mm for lap joints and perimeter seals, 50 mm wide elsewhere.
- .3 Sealant: Asbestos free non-hardening sealant, compatible with vapour retarder materials, recommended by vapour retarder manufacturer in accordance with Section 07 92 00.
- .4 Fasteners: Provide non-corrosive metal screws, nails, plastic clips and other fasteners as recommended by air/vapour retarder manufacturer required for complete installation of Work.
- .5 Staples: minimum 6 mm leg.
- .6 Moulded Box Vapour Retarder: Factory moulded polyethylene box purpose made for use with recessed electric switch and outlet device boxes.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 EXAMINATION

- .1 Examine surfaces to receive membrane. Notify Departmental Representative if surfaces are not acceptable. Do not begin installation until unacceptable conditions have been corrected.

3.3 INSTALLATION: SHEET MATERIALS

- .1 Install two (2) layers of building paper air barrier sheets in direct contact with exterior side of exterior wall sheathing before windows and doors are installed; eliminate any voids behind air barrier by wrapping sheet materials over projections or recesses in wall construction.
- .2 Install in a horizontal manner starting at the lower portion of the wall with subsequent layers installed in a shingle pattern to overlap lower layers. Maintain weather barrier plumb and level.
- .3 Overlapping:
 - .1 Wrap corners of building with a minimum overlap of 300 mm.
 - .2 Overlap horizontal seams a minimum of 100 mm.
 - .3 Overlap vertical seams a minimum of 150 mm.
 - .4 Install second layer of building paper air barrier sheets having an offset of 50% of roll width and same corner and seam overlap widths as the first layer.

- .4 Attach air barrier to sheathing using plastic capped nails placed at a maximum vertical spacing of 450 mm on center along each stud line.
- .5 Cut window and door rough openings as follows:
 - .1 Windows:
 - .1 Cut modified "I" pattern in the air barrier sheet.
 - .2 Cut horizontally along bottom of header.
 - .3 Cut vertically down centre of opening from top down to 2/3 of the way to the bottom.
 - .4 Cut diagonally from bottom vertical cut to left and right corners of opening.
 - .5 Fold side and bottom flaps into window opening and fasten at 150 mm on center and trim off excess material.
 - .2 Doors:
 - .1 Cut standard "I" pattern air barrier sheet.
 - .2 Cut horizontally along bottom of door frame header and along top of sill.
 - .3 Cut vertically cut down the centre of door openings from header to sill.
 - .4 Fold side flaps inside around door openings and fasten at 150 mm on center and trim off excess material.
- .6 Tape horizontal and vertical seam using manufacturer's recommended seaming tape; seal tears and cuts using manufacturer's recommended repair materials and methods.

3.4 INSTALLATION: SHEET VAPOUR BARRIER

- .1 Verify that services are installed and have been accepted by the Departmental Representative and Authorities Having Jurisdiction prior to installation of vapour retarder.
- .2 Install sheet vapour retarder on warm side of exterior wall, ceiling, and floor assemblies prior to installation of gypsum board to form continuous retarder in accordance with manufacturers written instructions.
- .3 Use sheets of largest practical size to minimize joints.
- .4 Install materials in a manner that maintains continuity; repair punctures and tears with sealing tape before work is concealed.
- .5 Openings:
 - .1 Cut sheet vapour retarder to form openings and lap and seal to window and door frames in accordance with good building envelope practice.
- .6 Seal perimeter of sheet vapour retarder as follows:
 - .1 Apply continuous bead of sealant to substrate at perimeter of sheets.
 - .2 Lap sheet over sealant and press into sealant bead.
 - .3 Install staples through lapped sheets at sealant bead into wood substrate.
 - .4 Install sealant bead with no gaps; smooth out folds and ripples occurring in sheet over sealant.
- .7 Seal lap joints of sheet vapour retarder as follows:

- .1 Attach first sheet to substrate.
- .2 Apply continuous bead of sealant over solid backing at joint.
- .3 Lap adjoining sheet minimum 150 mm and press into sealant bead.
- .4 Install staples through lapped sheets at sealant bead into wood substrate.
- .5 Install sealant bead with no gaps; smooth out folds and ripples occurring in sheet over sealant.
- .8 Seal electrical switch and outlet device boxes that penetrate vapour retarder as follows:
 - .1 Install moulded box vapour retarder:
 - .2 Apply sealant to seal edges of flange to main vapour retarder and seal wiring penetrations through box cover.

3.5 INSTALLATION: UNDERSLAB SHEET VAPOUR BARRIER

- .1 Install vapour barrier in accordance with manufacturer's written instructions and ASTM E1643, and generally as follows:
 - .1 Unroll vapour barrier with the longest dimension parallel to direction of concrete placement.
 - .2 Lap vapour barrier onto face of grade beams.
 - .3 Overlap joints 200 mm and seal with manufacturer's required tape.
 - .4 Seal penetrations including pipe and conduit risers in accordance with manufacturer's written instructions.
 - .5 Make no additional penetrations except as required for placing of reinforcing steel and permanent utilities.
- .2 Repair damaged areas by cutting patches of vapour barrier membrane; sized to overlap damaged area a minimum of 150 mm to each side of puncture; and tape all sides using manufacturer's required tape.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 05 50 00 – Metal Fabrications
- .2 Section 07 62 00 – Sheet Metal Flashing and Trim
- .3 Section 07 92 00 – Sealants

1.2 REFERENCES

- .1 American Association Inc. (AAI)
 - .1 DAF-45-03, Designation System for Aluminum Finishes.
- .2 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
- .3 American National Standards Institute (ANSI)
 - .1 ANSI/ASME B18.6.3-2013, Machine Screws, Tapping Screws, and Metallic Drive Screws (Inch Series).
- .4 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM A653/A653M-15e1, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM A792/A792M-10(2015), Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
 - .3 ASTM D523-14, Standard Test Method for Specular Gloss.
 - .4 ASTM D822/D822M-13, Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.
 - .5 ASTM D2369-10 (2015)e1, Standard Test Method for Volatile Content of Coatings.
 - .6 ASTM D2832-92(2016), Standard Guide for Determining Volatile and Nonvolatile Content of Paint and Related Coatings.
 - .7 ASTM F1667-17, Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.
- .5 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-51.32-M77, Sheathing, Membrane, Breather Type.
- .6 Canadian Standards Association (CSA International)
 - .1 CSA S136-12, North American Specification for the Design of Cold-Formed Steel Structural Members, Includes Update No. 1 (2014) Update No. 2 (2015) Update No. 3 (2015).
 - .2 CSA S136.1-12, Commentary on North American Specification for the Design of Cold-Formed Steel Structural Members.
- .7 Environmental Choice Program (ECP)
 - .1 UL 2761, (formerly CCD-045) Sealants and Caulking Compounds.
 - .2 UL 2762, (formerly CCD-046) Adhesives.

1.3 PRE-INSTALLATION MEETINGS

- .1 Convene pre-installation meeting one week prior to beginning work of this Section and on-site installation, with Contractor, Departmental Representative, installer, manufacturer's representative to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.
- .2 Manufacturer's representative shall also provide frequent inspection visits during the course of work of this Section to assure quality and competence of membrane installation and panel alignment.

1.4 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittals:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet.
 - .2 Submit WHMIS MSDS - Material Safety Data Sheets acceptable to Labour Canada, and Health and Welfare Canada. Indicate VOC's:
 - .1 Caulking and sealant materials during application and curing.
 - .2 Finishing materials.
 - .3 Insulation adhesives.
 - .4 Paints.
 - .5 Isolation coatings.
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittals:
 - .1 Indicate arrangement of cladding system including dimensions, wall openings, location of joints, profiles of inner and outer skin, types and locations of supports, fasteners, flashing, closures, compliance with design criteria and requirements of related work.
- .3 Submit samples in accordance with Section 01 33 00 – Submittals:
 - .1 Submit duplicate 300 x 300 mm samples of wall system, representative of materials, finishes and colours.
 - .2 Prior to ordering materials, provide to Departmental Representative the following for verification purposes: three samples of colour of finish specified.
- .4 Manufacturer's Instructions:
 - .1 Submit manufacturer's installation instructions.
- .5 Manufacturers' Field Reports: Submit copies of manufacturers field reports.

1.5 QUALITY ASSURANCE

- .1 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.

- .2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .3 Installer Qualifications: Engage experienced installer, who has completed systems similar in material, design, and extent to that indicated for Project and with record of successful performance.

1.6 MOCK-UPS

- .1 Construct mock-up in accordance with Section 01 45 00 – Quality Control.
- .2 Construct a portion of one exterior wall in location agreed upon by Departmental Representative to establish a standard of construction, workmanship, and appearance.
- .3 Construct mock-up indicating relationship between wall panels, air spaces, air/vapour retarder membrane, windows, and doors.
- .4 Do not continue with work of this Section until Departmental Representative has approved mock-up.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver and store materials in accordance with manufacturer's instructions.
- .2 Protect panels during transportation, unloading, storing, and erecting to prevent bending, warping, twisting, and surface damage.

1.8 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Waste Management and Disposal.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturers: Subject to compliance with requirements specified in this Section and as established by the Basis-of-Design Materials, manufacturers offering products that may be incorporated into the Work include; but are not limited to, the following:
 - .1 Behlen Industries
 - .2 VicWest Steel
 - .3 Westform Metals

2.2 PERFORMANCE/DESIGN CRITERIA

- .1 Design metal panel wall system in accordance with CSA S136.
- .2 Design metal panel wall to provide for thermal movement of component materials caused by ambient temperature range of 60 degrees C without causing buckling, failure of joint seals, undue stress on fasteners or other detrimental effects.
- .3 Include expansion joints to accommodate movement in wall system and between wall system and building structure, caused by structural movements, without

permanent distortion, damage to infills, racking of joints, breakage of seals, or water penetration.

- .4 Design members to withstand dead load and wind loads calculated in accordance with National Building Code 2015 and applicable local regulations, to maximum allowable deflection of 1/180th of span.
- .5 Provide for positive drainage of condensation occurring within wall construction and water entering at joints, to exterior face of wall in accordance with NRC "Rain Screen Principles".
- .6 Provide minimum thermal resistance of RSI 2.1 W/m²K.
- .7 Permeance through wall system not to exceed 1 ng/(Pa.s.m²).
- .8 Design wall system to accommodate specified erection tolerances of structure.
- .9 Design wall system to allow for movement of air between exterior and interior side of metal cladding.
- .10 Provide an effective air barrier, to prevent infiltration and/or exfiltration of air through wall assembly.

2.3 STEEL CLADDING MATERIALS

- .1 Aluminum-zinc galvanized sheet steel cladding: AZM180 galvalume sheet steel applied to both sides, commercial steel (CS), type A, grade 275 to ASTM A792 and as follows:
 - .1 Nominal Core Thickness: 0.76 mm or thicker to meet design loads.
 - .2 Profile: to match drawings
 - .3 Galvanizing Coating: Dofasco Inc., Galvalume Plus.
 - .4 Finish: prefinished as specified below

2.4 PREFINISHED STEEL SHEET

- .1 Prefinished steel with factory applied polyvinyl chloride.
 - .1 Class: F1S
 - .2 Colour: as indicated on Drawings.
 - .3 Specular gloss: 30 units +/-5 to ASTM D523.
 - .4 Coating thickness: not less than 200 micrometres.
 - .5 Resistance to accelerated weathering for chalk rating of 8, colour fade 5 units or less and erosion rate less than 20% to ASTM D822 as follows:
 - .1 Outdoor exposure period 5000 hours.
 - .2 Humidity resistance exposure period 5000 hours.

2.5 ACCESSORIES

- .1 Thermal Spacers: low-conductivity, fibreglass thermal spacers as follows:
 - .1 Depth: 150 mm and as indicated on Drawings.
 - .2 Spacing: as indicated on Drawings or as required to suit conditions.
 - .3 Fasteners: as recommended by manufacturer in length to suit wall construction.
 - .4 Acceptable Materials:

- .1 Cascadia Clip, by Cascadia Windows Ltd.
- .2 ISO Clip, Northern Facades
- .2 Sub-girts: minimum 1.21 mm base metal thickness, galvanized steel to ASTM A653/A653M, grade 230 with Z275 zinc coating; profiled to accept exterior sheet with structural attachment to building frame. Exposed materials of wall assembly to match panels.
- .3 Fasteners: Manufacturer's standard to suit design loads and applications.
 - .1 Screws to ANSI B18.6.4. Purpose made stainless steel; exposed parts to match finish of exterior sheet.
- .4 Sealant: as indicated in Section 07 92 00 and as recommended by manufacturer. Colour of exposed sealant to match adjacent panel.
- .5 Isolation coating: bituminous paint.
- .6 Exterior corners: of same profile, material and finish as adjacent cladding material, shop cut and brake formed to required angle, concealed corner brace, mechanically fasten connections with painted head to match cladding.
- .7 Exposed joint (perpendicular to profile): ends of cladding sheet shop cut clean and square, backed with tight fitting filler lapping back of joint, exposed components colour matched to cladding.
- .8 Accessories: cap flashings, drip flashings, internal corner flashings, copings and closures for head, jamb, sill and corners, of same material, thickness and finish as exterior cladding, brake formed to shape.
- .9 Expansion joints: as recommended by Manufacturers Instructions.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: Comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.2 PREPARATION

- .1 Protect metal surfaces in contact with concrete, masonry mortar, plaster or other cementitious surface with isolation coating.
- .2 Touch up building framing members with primer as required.

3.3 INSTALLATION

- .1 Install cladding horizontal on curved walls in accordance with CGSB 93.5, and manufacturer's written instructions
- .2 Install continuous starter strips, inside and outside corners, edgings, soffit, drip, cap, sill and window/door opening flashings as indicated.
- .3 Install outside corners, fillers and closure strips with carefully formed and profiled work.
- .4 Maintain joints in exterior cladding, true to line, tight fitting, hairline joints.

- .5 Attach components in manner not restricting thermal movement.
- .6 Caulk junctions with adjoining work with sealant. Do work in accordance with Section 07 92 00 - Joint Sealing.

3.4 CONTROL/EXPANSION JOINTS

- .1 Construct control and expansion joints as indicated.
- .2 Use cover sheets, of brake formed profile, of same material and finish as adjacent material.
- .3 Use mechanical fasteners to secure sheet materials.
- .4 Assemble and secure wall system to structural frame so stresses on sealants are within manufacturers' recommended limits.

3.5 CONSTRUCTION

- .1 Installation Tolerances: Shim and align panels and cladding system within installed tolerance of 6 mm in 6100 mm on level, plumb, and location lines as indicated, and within 3 mm offset of adjoining faces and of alignment of matching profiles.

3.6 FIELD QUALITY CONTROL

- .1 Have manufacturer of products supplied under this Section review Work involved in handling, installation/application, protection and cleaning of its products, and submit written reports in acceptable format to verify compliance of Work with Contract.
- .2 Manufacturer's field services: Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
- .3 Schedule site visits to review Work at stages listed:
 - .1 After delivery and storage of products, and when preparatory Work on which Work of this Section depends is complete, but before installation begins.
 - .2 Twice during progress of Work at 25% and 60% complete.
 - .3 Upon completion of Work, after cleaning is carried out.
- .4 Submit reports to Departmental Representative within three days of review and submit.

3.7 CLEANING

- .1 Perform cleaning after installation to remove construction and accumulated environmental dirt.
- .2 Wash down exposed interior and exterior surfaces using solution of mild domestic detergent in warm water, applied with soft clean wiping cloths. Wipe interior surfaces clean as part of final clean-up.
- .3 Remove excess sealant with recommended solvent.

- .4 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 06 10 00 – Rough Carpentry
- .2 Section 07 21 13 – Board Insulation
- .3 Section 07 27 19 – Sheet Membrane Air and Vapour Barrier
- .4 Section 07 62 00 – Sheet Metal Flashing and Trim
- .5 Section 09 21 16 – Gypsum Board Assemblies
- .6 Section 09 91 00 – Painting

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM D5116-10, Standard Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials/Products.
 - .2 ASTM F1667-17, Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.
- .2 Environmental Choice Program (ECP)
 - .1 UL 2761 (formerly CCD-045) 2011, Sealants and Caulking Compounds.
- .3 National Lumber Grades Authority (NLGA)
 - .1 NLGA Standard Grading Rules for Canadian Lumber 2014.
- .4 Western Red Cedar Lumber Association (WRCLA)

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-installation Meetings:
 - .1 Convene pre-installation meeting one week prior to beginning work of this Section, with Contractor, Owner, installer, manufacturer's representative in accordance with Section 01 31 19 – Project Meetings to:
 - .1 Verify project requirements.
 - .2 Review structural load limitations.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions.

1.4 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittals.
 - .1 Submit manufacturer's printed product literature, specifications and data sheet.
 - .2 Submit WHMIS MSDS - Material Safety Data Sheets. WHMIS MSDS acceptable to Labour Canada and Health and Welfare Canada for asphalt shingles. Indicate VOC content.
- .2 Submit samples in accordance with Section 01 33 00 – Submittals.

- .1 Submit duplicate siding and soffit in specified width, 600 mm long, in dry condition.
 - .3 Manufacturer's Instructions: Provide to indicate special handling criteria and installation sequence.
 - .4 Submit closeout data in accordance with Section 01 78 00 – Closeout Submittals.
 - .1 Provide manufacturer's printed recommendations for general maintenance, including cleaning instructions.
- 1.5 QUALITY ASSURANCE**
 - .1 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
 - .2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- 1.6 MOCK-UPS**
 - .1 Construct mock-ups in accordance with Section 01 45 00 - Quality Control.
 - .2 Construct typical exterior wall panel, 3 m long by 4 m wide, incorporating window openings with frame and sill installed, cladding, insulation, building corner condition, junction with roof system; illustrating materials interface and seals.
 - .3 Locate where directed.
 - .4 Mock-up may remain as part of Work.
 - .5 Allow 48 hours for review of mock-up by Departmental Representative before proceeding with work.
- 1.7 DELIVERY, STORAGE AND HANDLING**
 - .1 Deliver, handle, store and protect materials in accordance with manufacturer's instructions.
 - .2 Store materials in safe area, away from construction traffic; store under cover and off ground, protected from moisture.
- 1.8 WASTE MANAGEMENT AND DISPOSAL**
 - .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

- .1 Exterior Horizontal Wood Siding– Western Red Cedar, kiln dried, Select Knotty Grade, tongue and groove, v-grooved on two sides with finish as specified.
 - .1 Pattern: tongue and groove
 - .2 Grade: "A" clear or better.
 - .3 Treatment: Heat Treated –thermowood
 - .4 Moisture Content: kiln dried to 5 - 7% moisture content.

- .5 Density: 350 – 480 kg/m³
- .6 Board Size:
 - .1 Facade: 61 – 80 mm wide x 31 mm thick.
 - .2 Soffit: 25 mm thick x 150 – 200 mm wide.
- .7 Finish: stained both sides as indicated in Section 09 91 00.
- .8 Acceptable Material:
 - .1 Thermowood, Finnforest
 - .2 ThermoForest, Superior Thermo Wood

2.2 ACCESSORIES

- .1 Manufacturers standard exposed trim, closures, cap pieces and other accessories required for complete installation.
- .2 Girts: Fabricated from minimum 1.27 mm thickness galvanized steel to ASTM A653, Grade 230 with Z275 coating. Material visible after assembly of wall panel shall be finished as directed by Departmental Representative.
- .3 Sub-girts: Structural quality steel to ASTM A653, with Z275 zinc coating to ASTM A792, adjustable double-angle profile as indicated to accept panel with structural attachment to building frame.
- .4 Fasteners: nails to ASTM F1667, No. 316 stainless steel, sized as required, splitless siding nail type with flat head, length sufficient to penetrate solid wood minimum 32 mm.
- .5 Sealants: as indicated in Section 07 92 00.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- .2 Select siding boards of longest possible lengths. Discard boards that are warped, twisted, bowed, crooked or otherwise defective.

3.2 INSTALLATION

- .1 Install sill flashings, wood starter strips, inside corner flashings, edgings and flashings over openings.
- .2 Fasten wood siding in straight, aligned lengths to furring.
- .3 Seal cut surfaces. Apply touch up coats as required.

3.3 CLEANING

- .1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

3.4 MAINTENANCE

- .1 Explain proper maintenance procedures to Owner's Representative at project closeout.
- .2 Visually inspect siding, caulking, flashing annually for overall condition. Re-apply caulking and coating as necessary. Adjust flashing as required.
- .3 The use of pressure washers is not recommended.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 06 10 00 – Rough Carpentry
- .2 Section 07 21 13 – Board Insulation
- .3 Section 07 27 19 – Sheet Membrane Air and Vapour Barrier
- .4 Section 07 62 00 – Sheet Metal Flashing and Trim
- .5 Section 07 92 00 – Sealants
- .6 Section 09 21 16 – Gypsum Board Assemblies
- .7 Section 09 22 00 – Non Structural Metal Framing

1.2 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM A653/A653M-15e1, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
 - .3 ASTM C1185-08(2016), Standard Test Methods for Sampling and Testing Non-Asbestos Fibre-Cement Flat Sheet, Roofing and Siding Shingles, and Clapboards.
 - .4 ASTM C1186-08(2016), Standard Specification for Flat Fiber-Cement Sheets.
 - .5 ASTM E84-16, Standard Test Methods for Surface Burning Characteristics of Building Materials.
 - .6 ASTM E96/E96M-16, Standard Test Methods for Water Vapor Transmission of Materials.
 - .7 ASTM E136-16a, Standard Test Method for Behaviour of Materials in a Vertical Tube Furnace at 750°C.
 - .8 ASTM E228 - Standard Test Method for Linear Thermal Expansion of Solid Materials With a Vitreous Silica Dilatometer.
 - .9 ASTM G26 - Standard Practice for Operating Light-Exposure Apparatus (Xenon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .3 Underwriters Laboratories' of Canada (ULC)
 - .1 CAN/ULC S102-11, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC S114-05, Standard Method of Test for Determination of Non-Combustibility in Building Materials

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Sequencing: Coordinate installation with flashings and other adjoining construction to ensure proper sequencing.

1.4 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittals:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet and include:
 - .1 Preparation instructions and recommendations.
 - .2 Installation instructions.
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittals:
 - .1 Provide shop drawings indicating attachment methods, joinery, sealing methods and compliance with design criteria and requirements of related work.
- .3 Submit samples in accordance with Section 01 33 00 – Submittals:
 - .1 Submit duplicate 150 mm long samples of wall system in each type, colour, texture and pattern required. Include clips, caps, battens, fasteners, closures and other exposed accessories.

1.5 QUALITY ASSURANCE

- .1 Installer Qualifications: Engage experienced installer who has completed systems similar in material, design, and extent to that indicated for Project and with record of successful performance.
- .2 Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship of the following details:
 - .1 Sill and head connections at windows and penetrations
 - .2 Joint between panels
 - .3 Detailing of corner caps and flashings.
 - .4 Do not proceed with remaining Work until mock-up has been reviewed by Departmental Representative
 - .5 Refinish mock-up area as required to produce acceptable Work; at no additional cost to the Owner

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Store products in manufacturer's unopened packaging until ready for installation.
- .2 Store siding flat on a smooth level surface. Protect edges and corners from chipping. Store sheets under cover and keep dry prior to installing.

1.7 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for recycling in accordance with Section 01 74 21 - Waste Management and Disposal.

1.8 ENVIRONMENTAL REQUIREMENTS

- .1 Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
- .2 Proceed with siding installation when substrate is completely dry.

1.9 WARRANTY

- .1 Manufacturer's Warranty: Submit manufacturer's standard warranty that panels are free from defects in materials and workmanship beginning from the date of substantial completion and as follows:
 - .1 Product Warranty: manufacturers standard limited, non prorated product warranty for a period of 30 years.
 - .2 Workmanship Warranty: 2 year
 - .3 Finish Warranty: 15 years: Deterioration of finish includes, but is not limited to, chipping, cracking, and peeling.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturers: Subject to compliance with requirements specified in this Section, manufacturers offering products that may be incorporated into the Work include; but are not limited to, the following:
 - .1 Allura Fiber Cement Products, Plycem
 - .2 James Hardie Industries Inc.

2.2 PERFORMANCE/DESIGN CRITERIA

- .1 Design composite building panel wall to provide for thermal movement of component materials caused by ambient temperature range of 80 degrees C without causing buckling, failure of joint seals, undue stress on fasteners or other detrimental effects.
- .2 Include expansion joints to accommodate movement in wall system and between wall system and building structure, caused by structural movements, without permanent distortion, damage to infills, racking of joints, breakage of seals, or water penetration.
- .3 Design members to withstand dead load and wind loads calculated in accordance with current Building Code and applicable local regulations, to maximum allowable deflection of 1/180th of span.
- .4 Provide for positive drainage of condensation occurring within wall construction and water entering at joints, to exterior face of wall in accordance with NRC "Rain Screen Principles".
- .5 Design wall system to accommodate specified erection tolerances of structure.
- .6 Maintain following installation tolerances:
 - .1 Maximum variation from plane or location shown on drawings: 3 mm/m of length and up to 20 mm/100 m maximum.
 - .2 Maximum offset from true alignment between two adjacent members abutting end to end, in line: 0.75 mm.

2.3 MATERIALS

- .1 Fibre Cement Board Panels: Panels made from fibre reinforced cement board, free from asbestos fibres; in accordance with ASTM C1186 Type A, Grade II; and as follows:

- .1 Surface Burning Characteristics: Flame spread index of 0, smoke developed index of 5, maximum; when tested in accordance with ASTM E84.
- .2 Combustibility: Noncombustible, when tested in accordance with ASTM E136, ULC S135 and ULC S114.
- .3 Flexural Strength: 10 MPa when in equilibrium condition, and 7 MPa when in wet condition, tested in accordance with ASTM C1185.
- .4 Freeze Thaw Resistance: 80 percent flexural strength retained, when tested in accordance with ASTM C1185.
- .5 UV Resistance: No cracking, checking, or erosion.
- .6 Water Tightness: No water droplets on underside, when tested in accordance with ASTM C1185.
- .2 Horizontal Fibre Cement Siding:
 - .1 Thickness: 7.9 mm.
 - .2 Width: as indicated on Drawings.
 - .3 Edge Style: Lapped.
 - .4 Texture: as indicated on Drawings.
 - .5 Factory Finish: Manufacturers standard factory applied finish in colour, as indicated on Drawings.
 - .6 Basis-of-Design:
 - .1 HardiePlank, James Hardie Inc.
 - .2 Allura Lap Siding

2.4 ACCESSORIES

- .1 Thermal Clips: 100 mm Fiberglass clips: Cascadia Clip to suit installation and details.
- .2 Subgirts: Rolled, Z-shaped, Z-275 galvanized steel girts to suit design loads and application.
- .3 Hat Sections and Other Sub framing: Rolled shapes, Z-275 galvanized steel to suit design loads and application.
- .4 Siding Accessories: Provide starter strips, edge trim, corner cap, perforated soffit boards and other items as recommended by siding manufacturer for building configuration, and as follows:
 - .1 Provide accessories made from same material as adjacent siding, unless otherwise indicated.
 - .2 Provide accessories matching colour and texture of adjacent siding, unless otherwise indicated.
- .5 Flashing: Provide pre-finished, galvanized sheet steel flashing and trims in accordance with Section 07 62 00, at window and door heads and where indicated.
- .6 Gaskets: Manufacturer's standard type suitable for use with system, permanently resilient; ultraviolet and ozone resistant; colour as directed.
- .7 Elastomeric Joint Sealant: single component polyurethane sealant joint sealant in accordance with Section 07 92 00.

- .8 Fasteners: Corrosion resistant fasteners as recommended by siding manufacturer for materials being fastened to and as follows:
 - .1 Fastening to Wood: Ribbed, bugle head screws of sufficient length to penetrate a minimum of 25 mm into substrate.
 - .2 Fastening to Metal: Ribbed, bugle head screws of sufficient length to penetrate a minimum of 6 mm or 3 - screw threads into substrate.
- .9 Touch Up Kit: Provide manufacturers standard touch-up kit for each colour provided.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.2 PREPARATION

- .1 Building surfaces shall be smooth, clean and dry, and free from defects detrimental to the installation of the system. Notify Contractor of conditions not acceptable for installation of system.
- .2 Proceed with installation only after unsatisfactory conditions have been corrected.
- .3 Ensure air/vapour barrier installation is complete and has been reviewed by the Departmental Representative.

3.3 INSTALLATION: HORIZONTAL LAP SIDING

- .1 Install materials in strict accordance with manufacturer's installation instructions.
- .2 Starting: Install a minimum 6 mm thick lath starter strip at the bottom course of the wall. Apply planks horizontally with minimum 32 mm wide laps at the top. The bottom edge of the first plank overlaps the starter strip.
- .3 Allow minimum vertical clearance between the edge of siding and any other material in strict accordance with the manufacturer's installation instructions.
- .4 Align vertical joints of the planks over framing members.
- .5 Maintain clearance between siding and adjacent finished grade.
- .6 Locate splices at least one stud cavity away from window and door openings.
- .7 Face nail to rain screen strapping.
- .8 Locate splices at least 305 mm away from window and door openings.
- .9 Specific framing and fastener requirements: refer to the applicable building code compliance reports.
- .10 Site paint exposed cut edges to match colour of board, trim, or plank.

3.4 INSTALLATION: TRIM AND MOULDING

- .1 Install materials in strict accordance with manufacturer's installation instructions. Install flashing around all wall openings.
- .2 Fasten through trim into structural framing or code complying sheathing. Fasteners must penetrate minimum 25 mm plus full thickness of sheathing. Additional fasteners may be required to ensure adequate security.
- .3 Place fasteners no closer than 19 mm and no further than 51 mm from side edge of trim board and no closer than 25 mm from end. Fasten maximum 406 mm on center.
- .4 Maintain clearance between trim and adjacent finished grade.
- .5 Trim inside corner with single board.
- .6 Outside Corner Board: Attach trim on both sides of corner with 16 gage corrosion resistant finish nail 13 mm from edge spaced 406 mm apart, weather cut each end spaced minimum 305 mm apart.
- .7 Allow 3 mm gap between trim and siding.
- .8 Seal gap with high quality, paint-able sealant.
- .9 Shim frieze board as required to align with corner trim.
- .10 Site paint exposed cut edges to match colour of board, trim, or plank.

3.5 TOUCH-UPS

- .1 Factory Finish Touch Up: Apply touch up paint to cut edges in accordance with manufacturer's printed instructions.
 - .1 Touch-up nicks, scrapes, and nail heads in pre-finished siding using the manufacturer's touch-up kit pen.
 - .2 Touch-up of nails shall be performed after application, but before plastic protection wrap is removed to prevent spotting of touch-up finish.
 - .3 Use touch-up paint sparingly. If large areas require touch-up, replace the damaged area with new pre-finished siding. Match touch up colour to siding colour through use of manufacturer's branded touch-up kits.

3.6 CLEANING

- .1 Remove damaged, improperly installed, or otherwise defective siding materials and replace with new materials complying with specified requirements.
- .2 Clean finished surfaces according to siding manufacturer's written instructions and maintain in a clean condition during construction.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 06 10 00 – Rough Carpentry
- .2 Section 07 21 13 – Board Insulation
- .3 Section 07 42 13 – Preformed Metal Siding
- .4 Section 07 62 00 – Sheet Metal Flashing and Trim
- .5 Section 07 92 00 - Sealants

1.2 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM A653/A653M-15e1, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM A755/A755M-16e1, Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products.
 - .3 ASTM A792/A792M-10(2015), Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot Dip Process.
 - .4 ASTM D523-14, Standard Test Method for Specular Gloss.
 - .5 ASTM D822/D822M-13, Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.
- .2 Canadian Standards Association (CSA International)
 - .1 CSA A123.5-16, Asphalt Shingles Made From Organic Felt and Surfaced With Mineral Granules / Asphalt Shingles Made From Glass Felt and Surfaced With Mineral Granules.
 - .2 CSA S136-12, North American Specification for the Design of Cold Formed Steel Structural Members, Includes Update No. 1 (2014).
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .4 National Research Council Canada (NRC)/Institute for Research in Construction (IRC) - Canadian Construction Materials Centre (CCMC)
 - .1 CCMC-2002, Registry of Product Evaluations.
- .5 Roofing Contractor's Association of British Columbia (RCABC)
 - .1 Roofing Practices Manual
 - .2 Roofing Contractors Association of B.C. Guarantee Corp. Guarantee Program.
- .6 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 Architectural Sheet Metal Manual, 7th Edition, 2012.

1.3 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittals:

- .1 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with WHMIS acceptable to Labour Canada, and Health and Welfare Canada.
- .2 Submit product data sheets for [bitumen] [roofing felts] [insulation]. Include:
 - .1 Product characteristics.
 - .2 Performance criteria.
 - .3 Limitations.
- .2 Submit samples in accordance with Section 01 33 00 – Submittals:
 - .1 Submit duplicate 300 x 300mm samples of each sheet metal material.
- .3 Submit proof of manufacturer's CCMC Listing and listing number to Departmental Representative.
- .4 Manufacturer's Instructions: Provide to indicate special handling criteria, installation sequence and cleaning procedures.

1.4 QUALITY ASSURANCE

- .1 Installer Qualifications: Engage experienced installer who has completed systems similar in material, design, and extent to that indicated for Project and with record of successful performance.
- .2 Obtain each type of metal roofing system through one source from a single manufacturer.

1.5 MOCK-UPS

- .1 Submit mock-ups in accordance with Section 01 45 00 - Quality Control.
- .2 Mock-up will be used:
 - .1 To judge workmanship, substrate preparation, operation of equipment and material application.
- .3 Locate where directed.
- .4 Allow 24 hours for inspection of mock-up by Departmental Representative before proceeding with sheet metal flashing work.
- .5 When accepted, mock-up will demonstrate minimum standard of quality required for this Work. Approved mock-up may remain as part of finished Work.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver and store materials in accordance with manufacturer's instructions.
- .2 Protect panels during transportation, unloading, storing, and erecting to prevent bending, warping, twisting, and surface damage.

1.7 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Waste Management and Disposal.

1.8 WARRANTY

- .1 Provide RCABC Warranty Certificate for 5 years as indicated in Roofing Manual.

- .2 Manufacturers Warranty for Finishes: Twenty (20) years from date of Substantial Performance.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturers: Subject to compliance with requirements specified in this Section, manufacturers offering products that may be incorporated into the Work include the following:
 - .1 Behlen Industries
 - .2 Berridge Manufacturing Company
 - .3 Vicwest Steel Inc.
 - .4 Westform Metals

2.2 PERFORMANCE/DESIGN CRITERIA

- .1 General: The complete roof cladding system shall meet the following performance/design criteria and maintain its intended appearance, remain wind and watertight, allow for expansion and contraction of metal components and transmit loads to the supporting structural back-up.
- .2 The design, and erection of a complete metal roof system is the responsibility of this subcontractor and are based on the performance criteria specified. The method assembly, reinforcing and anchorage is schematic and shows general intent only. Location and methods of providing same shall be this subcontractor's responsibility who shall design the assembly, reinforcing and anchorage to suit specific conditions in an acceptable manner complying with the requirements specified herein.
- .3 Provide flashing as shown and required to make the system wind and watertight, and still allow for thermal movement.
- .4 All fastenings shall be concealed where possible. Where exposed in finished surfaces, screw heads shall be neat and symmetrical, made completely watertight and capable of allowing expansion and contraction of metal roof cladding. Exposed fasteners shall be color-matched to finished metal cladding or stainless steel and as scheduled.
- .5 Design and install panel system and all connections to withstand earthquake forces and wind loads in accordance with the requirements of the BC Building Code
- .6 Thermal Movements and Wind Loads: The metal wall and associated flashing systems shall be so designed and constructed as to provide for such expansion and contraction of component materials as will be caused by an ambient temperature range of -40°C to +60°C without causing harmful buckling, failure of joint seals, undue stress on fasteners or other detrimental effects.
- .7 Provide and/or make allowances for free noiseless vertical and horizontal thermal and wind loading movement, due to the contraction and expansion of any and all component parts.
- .8 Assembly and erection procedures shall take into account the ambient temperature range and wind pressure at the time of installation.

- .9 The system shall provide clear internal paths of drainage in order to drain any trapped moisture to the exterior, discharging moisture in a manner avoiding staining of architectural finishes, collecting in puddles, formation of unsafe icicles and dripping onto pedestrians.
- .10 Fasten panel assembly to building structure in a manner, which transmits all loads to the main structure without exceeding the capacity of any fastener.

2.3 SHEET METAL MATERIALS

- .1 Aluminum-zinc alloy coated steel sheet: to ASTM A792/A792M, commercial quality (CS), grade 275 with AZ150 galvalume coating and as follows:
 - .1 Base Metal Thickness: 0.61 mm.
 - .2 Surface: regular spangle
 - .3 Finish: prefinished as specified below.
 - .4 Profile:
 - .1 Panel Width: as directed
 - .2 Ribbed, shallow vee in direction of standing seam.
 - .3 Seam Profile: Standing Seam

2.4 PREFINISHED STEEL SHEET

- .1 Prefinished steel with factory applied polyvinyl chloride.
 - .1 Class: F1S.
 - .2 Colour: as indicated on Drawings
 - .3 Specular gloss: 30 units +/-5 to ASTM D523.
 - .4 Coating thickness: not less than 200 micrometres.
 - .5 Resistance to accelerated weathering for chalk rating of 8, colour fade 5 units or less and erosion rate less than 20% to ASTM D822 as follows:
 - .1 Outdoor exposure period 5000 hours.
 - .2 Humidity resistance exposure period 5000 hours.

2.5 VAPOUR BARRIER MEMBRANE

- .1 Air and Vapour Barrier and Primer: adhered SBS-modified bituminous membrane for high temperature applications; rubberized asphalt will not flow up to temperatures as high as 116°C.
 - .1 Primer: as recommended by manufacturer
 - .2 Acceptable materials:
 - .1 Grace Construction Products, Ice and Water Shield HT
 - .2 Soprema, Lastobond Shield HT

2.6 INSULATION

- .1 Fibrous Mineral Insulation: Unfaced, preformed rigid fibrous mineral slag board insulation in accordance with CAN/ULC S702 and as follows:
 - .1 Thermal Resistance: RSI 0.75/25 mm minimum.
 - .2 Combustion Characteristics: non-combustible in accordance with CAN/ULC S114.

- .3 Flamespread: 0 in accordance with CAN/ULC S102.
- .4 Density: 70 kg/m³. To ASTM C303
- .5 Edges: square.
- .6 Size: width of girts x 1220 mm x thickness as indicated on Drawings.
- .7 Acceptable Materials:
 - .1 Rockwool, Cavityrock.

2.7 VAPOUR RETARDER

- .1 Self adhered vapour retarder: SBS rubberized asphalt membrane, self adhering vapour retarder, having a non-slip surface and UV resistant opaque surface.
 - .1 Acceptable Materials:
 - .1 Modified Vapour Protector, IKO.
 - .2 Sopravap'R, Soprema.
 - .3 Vapor-Bloc SA, Bakor.

2.8 ACCESSORIES

- .1 Provide components required for complete metal roofing system assembly including trim, copings, fasciae, corner units, ridge cap, ridge closures, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items; match material and finish of metal roofing system.
- .2 Isolation coating: alkali resistant bituminous paint.
- .3 Plastic cement: to CAN/CGSB-37.5.
- .4 Underlay: No.15 perforated asphalt felt to CSA A123.3.
- .5 Slip sheet: reinforced sisal paper or a heavy felt kraft paper.
- .6 Sheet steel: liner sheet, structural quality, grade A to ASTM A653, with Z275 zinc coating:
 - .1 Light duty modified silicone finish.
 - .2 Dry film thickness: 0.025 mm.
 - .3 Colour: as indicated.
 - .4 Thickness: 0.45 mm.
- .7 Sealant: Asbestos-free sealant, compatible with systems materials, recommended by system manufacturer and as indicated in Section 07 92 00.
- .8 Rubber-asphalt sealing compound: to CAN/CGSB-37.29.
- .9 Fasteners: concealed.
- .10 Washers: of same material as sheet metal, 1 mm thick with rubber packings.
- .11 Flashing, Roof Curbs, Gutters and Downspouts, and Trim: Prefinished flashing materials to match roofing materials in accordance with Section 07 62 00
- .12 Touch-up paint: as recommended by sheet metal roofing manufacturer.
- .13 Snow Guards: continuous type, fabricated of non-corrosive prefinished metal as directed by Departmental Representative. Installed without penetrating metal roofing system, and complete with predrilled holes, clamps, or hooks for anchoring.

2.9 FABRICATION

- .1 Fabricate all components of the system in the factory, ready for field installation.
- .2 Provide roof sheet and all accessories in longest practicable length to minimize field lapping of joints.

Part 3 Execution

3.1 EXAMINATION

- .1 Examine substrates to ensure proper attachment to framing.
- .2 Examine roof deck to verify deck is clean and smooth, free of depressions, waves or projections and within flatness tolerances required by metal roofing system manufacturer
- .3 Verify roof opening, curbs, pipes, sleeves, ducts or vents through roof are solidly set, cant strips and reglets in place, and nailing strips located.
- .4 Verify deck is dry and free of snow or ice.

3.2 INSTALLATION

- .1 Install metal roofing system in accordance with manufacturer's written instruction.
- .2 Use concealed fastenings except where approved by Departmental Representative before installation.
- .3 Provide underlay under sheet metal roofing. Secure in place and lap joints 100 mm minimum.
- .4 Apply slip sheet over asphalt felt underlay to prevent bonding between sheet metal and felt. Secure with minimum anchorage and lap joints 50 mm minimum in direction of waterflow.
- .5 Install sheet metal roof panels using cleats spaced at 300 mm on centre.
- .6 Secure cleats with two fasteners each and cover with cleat tabs.
- .7 Stagger transverse seams in adjacent panels.
- .8 Flash roof penetrations with material matching roof panels, and make watertight.
- .9 Form seams in direction of water-flow and make watertight.

3.3 STANDING SEAM ROOFING

- .1 Fold lower end of each pan under 20 mm.
 - .1 Slit fold 25 mm away from corner to form tab where pan turns up to make standing seam.
 - .2 Fold upper end of each pan over 50 mm.
 - .3 Hook 20 mm fold on lower end of upper pan into 50 mm fold on upper end of underlying pan.
- .2 Apply sheet metal roofing beginning at eaves. Loose lock pans to valley flashing and edge strips at eaves and gable rakes.
- .3 Finish standing seams 25 mm high on flat surfaces. Bend up one side edge 40 mm and other 45 mm.

- .1 Make first fold 6 mm wide single fold and second fold 12 mm wide, providing locked portion of standing seam with 5 plies in thickness.
- .2 Fold lower ends of seams at eaves over at 45 degrees angle.
- .3 Terminate standing seams at ridge and hips by turning down in tapered fold.
- .4 Form valleys of sheets not exceeding 3 m in length. Lap joints 150 mm in direction of flow.
 - .1 Extend valley sheet minimum 150 mm under roofing sheets.
 - .2 At valley line, double fold valley and roofing sheets and secure with cleats spaced 450 mm on centre.

3.4 CLEANING

- .1 Remove temporary protective coverings and strippable films, if any, as metal roofing system are installed, unless otherwise indicated in manufacturer's written installation instructions.
- .2 Clean finished surfaces as recommended by metal roofing system manufacturer upon completion of metal roofing system installation; maintain in a clean condition during remainder of construction.
- .3 Replace metal roofing system components that become damaged or have deteriorated beyond successful repair by finish touch-up or similar minor repair procedures.
- .4 Remove all excess materials, debris and equipment at completion.
- .5 Clean all panels clean and free of all grime and dirt.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 06 10 00 – Rough Carpentry
- .2 Section 07 26 00 – Vapour and Air Retarder
- .3 Section 07 61 00 – Sheet Metal Roofing
- .4 Section 08 11 13 – Steel Doors and Frames
- .5 Section 08 11 16 – Aluminum Doors and Frames
- .6 Section 08 44 13 – Glazed Curtain Wall
- .7 Section 08 52 13 – Aluminum Clad Wood Windows

1.2 REFERENCES

- .1 The Aluminum Association Inc. (AA)
 - .1 Specifications for Aluminum Sheet Metal Work in Building Construction.
 - .2 DAF45-2003(R2009), Designation System for Aluminum Finishes.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A240/A240M-16a, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - .2 ASTM A606/A606M-15, Standard Specification for Steel, Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance.
 - .3 ASTM A653/A653M-15e1, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .4 ASTM A792/A792M-10(2015), Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
 - .5 ASTM B32-08(2014), Standard Specification for Solder Metal.
 - .6 ASTM B370-12, Standard Specification for Copper Sheet and Strip for Building Construction.
 - .7 ASTM D523-14, Standard Test Method for Specular Gloss.
 - .8 ASTM D822/D822M-13, Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.
 - .9 ASTM D4586/D4586M07(2012)e1, Standard Specification for Asphalt Roof Cement, Asbestos-Free.
- .3 Canadian Roofing Contractors Association (CRCA)
 - .1 Roofing Specifications Manual
- .4 Canadian Standards Association (CSA International)
 - .1 CSA A123.3-05 (R2015), Asphalt Saturated Organic Roofing Felt.
 - .2 AAMA/WDMA/CSA 101/I.S.2/A440-11, Standard/Specification for Windows, Doors, and Skylights, Includes Update No. 1 (2013).
 - .3 CSA B111-74(R2003), Wire Nails, Spikes and Staples.

- .5 Green Seal Environmental Standards
 - .1 Standard GS-03-97, Anti-Corrosive Paints.
 - .2 Standard GS-11-10, Paints and Coatings.
 - .3 Standard GS-36-15, Commercial Adhesives.
- .6 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .7 Sheet Metal and Air Conditioning Contractors' National Association ([SMACNA](#)):
 - .1 Architectural Sheet Metal Manual, 7th Edition, 2012
- .8 South Coast Air Quality Management District (SCAQMD), California State
 - .1 SCAQMD Rule #1113-04, Architectural Coatings.
 - .2 SCAQMD Rule #1168-05, Adhesives and Sealants.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Coordination:
 - .1 Coordinate work of this Section with interfacing and adjoining Work for proper sequencing of each installation and to provide positive weather resistance, durability of the work, and protection of materials and finishes.

1.4 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittals:
 - .1 Submit manufacturer's printed product literature for sheet metal flashing systems materials, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

1.5 QUALITY CONTROL

- .1 Installer: Engage an experienced installer who has completed projects similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- .2 Construct and install roof metal flashings in accordance with ARCA Manual details and in accordance with the ARCA Manual. If requirements conflict, this specification takes precedence over the manual.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Stack pre-formed and pre-finished material in manner to prevent twisting bending and rubbing.
- .2 Provide protection for galvanized surfaces.
- .3 Prevent contact of dissimilar metals during storage and protect from acids, flux, and other corrosive materials and elements
- .4 Protect prefinished surfaces from scratches and from rust staining.

1.7 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Waste Management and Disposal.

1.8 WARRANTY

- .1 The same warranty provisions apply to flashings associated with roofing as to the roofing.
- .2 Provide Warranty for sheet metal flashing and trim to include in maintenance manuals as specified in Section 01 78 00 – Operations and Maintenance Data Manuals.

Part 2 Products

2.1 METAL FLASHINGS

- .1 Zinc coated galvanized steel sheet (pre-finished): Type A commercial quality to ASTM A653/A653M, with Z275 designation zinc coating.
 - .1 Class: F2S-Finished two sides.
 - .2 Thickness: minimum 0.45 mm base metal thickness.
 - .3 Factory Finish: baked enamel paint to Dofasco/Stelco 8000 Series meeting standards specified in CSSBI Technical Bulletin 20M-91 zinc-coated steel.
 - .1 Acceptable materials:
 - .1 Valspar WeatherX or Dofasco Perspectra
 - .4 Colour: As indicated on drawings.
- .2 Formed aluminum flashings: Tension levelled, aluminum sheet in accordance with ASTM B209 and ANSI H35.1 alloy designation [3003-H14] [5005-H14] and as follows:
 - .1 Thickness: minimum [1.00 mm] [1.20 mm].
 - .2 Finish: [prefinished, [colour selected from manufacturer's standard range]] [shop finished, [colour to match window frames]] [anodized aluminum sheet, [clear] [bronze]]
- .3 Form flashings, copings and fascias to profiles indicated.

2.2 EAVES TROUGHS AND DOWNSPOUTS

- .1 Form downspouts from 0.55 mm thick prefinished aluminum sheet metal. Sizes and profiles as indicated.
- .2 Form eaves troughs from 0.55 mm thick prefinished aluminum sheet metal. Sizes and profiles as indicated.
- .3 Provide goosenecks, outlets, strainer baskets and necessary fastenings.

2.3 ACCESSORIES

- .1 Isolation coating: alkali resistant bituminous paint.
- .2 Roofing Cement: to ASTM D4586, asphalt based, asbestos free.
- .3 Underlay for metal flashing: No. 15 perforated asphalt felt to CSA A123.3.
- .4 Sealants: as indicated in Section 07 92 00 - Sealants.
 - .1 Mastic Sealant: CAN/CGSB 37.29 polyisobutylene; non-hardening, non-skinning, non-drying, non-migrating sealant.

- .2 Elastomeric Sealant: Generic type recommended by sheet metal manufacturer and fabricator of components being sealed and complying with requirements for joint sealants as specified in Section 07 92 00.
- .5 Fasteners: of same material as sheet metal, to CSA B111, as recommended by sheet metal manufacturer; non-corrosive. Finish of exposed parts to match material being fastened.
- .6 Washers: of same material as sheet metal, 1 mm thick with rubber packings.
- .7 Solder: to ASTM B32, alloy composition Sn.
- .1 Flux: rosin, cut hydrochloric acid, or commercial preparation suitable for materials to be soldered
- .8 Adhesives: Type recommended by flashing sheet metal manufacturer for waterproof and weather resistant seaming and adhesive application of flashing sheet metal.
- .9 Metal Accessories: Provide non-corrosive sheet metal clips, straps, anchoring devices, and similar accessory units as required for installation of Work. Accessories shall match or be compatible with material being installed; size and thickness as required.
- .10 Touch-up paint: as recommended by prefinished material manufacturer.

2.4 FABRICATION

- .1 Fabricate sheet metal building flashings and trim in accordance with the recommendations of SMACNA's Architectural Sheet Metal Manual that apply to the design, dimensions, metal, and other characteristics as required.
- .2 Fabricate aluminum flashings and other sheet aluminum work in accordance with AAI-Aluminum Sheet Metal Work in Building Construction.
- .3 Form sections square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.
- .4 Apply isolation coating to metal surfaces to be embedded in concrete or mortar.
- .5 Make flashings of prefinished metal for all cap flashings, for all flashings adjacent to roofing at roof edges and area dividers and where exposed to view from ground. Make flashings for other locations, of plain galvanized metal as follows:
 - .1 Use 0.45 mm metal core thickness except where otherwise indicated.
 - .2 Use 0.62 mm metal core thickness wherever a flat length exceeding 305 mm wide occurs.
 - .3 Use 0.80 mm metal core thickness for concealed fastening strips.
- .6 All straight run joints shall be S-Lock.
- .7 Make joints to allow for thermal movement, space S-Lock joints at 2440 mm maximum centers.
- .8 Form non-expansion, but movable, joints in metal to accommodate elastomeric sealant in accordance with SMACNA standards.
- .9 Make flashings for building into masonry and concrete so that joints can be lapped 100 mm or more.
- .10 Strengthen free edges of metal flashings by folding to form a 13 mm hem.

- .11 Make flashings to curbs, walls and parapets a minimum of 200 mm high, where possible.
- .12 Where curb-mounted roof penetrations are not required, provide flashing sleeves and collars for all pipes and conduit extending through the roof. Sleeves shall be soldered to a piece of sheet metal extending at least 150 mm onto the surrounding roof.
- .13 Make joints for corners and intersections with standing seams except where exposed of pre-finished metal when seams shall be flat locked.
- .14 All bends machine made; form sections square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.
- .15 Fabricate cleats and attachment devices from same material as sheet metal component being anchored or from compatible, non-corrosive metal recommended by sheet metal manufacturer, and as follows:
 - .1 Size as recommended by SMACNA manual or sheet metal manufacturer for application but not less than thickness of metal being secured.
- .16 Back paint metal flashings in contact with dissimilar metals or materials with bituminous paint that would result in electrolytic action or corrosion.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSPECTION

- .1 Check mounting and counterflashing of mechanical items and report any defect to the Departmental Representative.
- .2 Verify that solid wood blocking or sheathing provided to back-up all flashings and that all nails, screws set and wood provides a smooth flat plane.
- .3 Verify that all reglets, provided under other Sections or built-in by other trades, properly and securely located, true and level in line.

3.3 PERFORMANCE REQUIREMENTS

- .1 Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing, rattling, leaking and fastener disengagement.
- .2 Install metal flashings on all surfaces such as roof cant edges, sleepers, parapets and cap type, wall junctions, roof dividers, curbs, roof control joints, through roof penetrations and the like, and as otherwise required to provide flashing type protection to details. Unless otherwise directed extend all flashings down and onto the horizontal portion of the roof. Additionally install counter and base flashings unless otherwise directed by the Departmental Representative.
- .3 Sheet metal flashings are intended to protect the roof membrane from accelerated deteriorating effects of the elements, and to limit mechanical damage

of the membrane, and are not intended to protect the work from direct migration of moisture. Ensure that the roofing system membrane terminations are fully water tight, without reliance on covering flashing.

- .4 Fasten and install roof edge flashing and copings capable of all resisting according to recommendations of FMG Loss Prevention Data Sheet 1-49, for wind conditions as outlined.
- .5 Provide sheet metal flashing and trim that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects:
 - .1 Provide clips that resist rotation and avoid shear stress as a result of sheet metal and trim thermal movements.
 - .2 Base engineering calculations on surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.
 - .3 Temperature change (range): 67°C ambient; 100°C material surfaces.
- .6 Provide sheet metal flashing and trim to create a rain screen assembly to the completed air/vapour and roofing membrane termination details.
- .7 Install prefinished metal fascia to complete edge details. Install as separate piece from flashing.
- .8 Call for inspection by roofing inspector, of completed roofing work prior to the installation of any metal flashings. Provide other flashing inspections, such as at start-up and periodic inspections, by the roofing inspector at frequencies required recommended by BCRCA.
- .9 Coordinate installation of flashing work of this Section with flashing work of other Sections which ties into this work. Coat surfaces of different metals such as aluminum and galvanized steel which are in contact to each other, with bituminous paint to prevent electrolysis.

3.4 INSTALLATION: METAL FLASHING

- .1 Apply metal roof flashing to ARCA recommended requirements as a minimum.
- .2 Install sheet metal flashing and trim in accordance with performance requirements, manufacturer's installation instructions, and SMACNA's Architectural Sheet Metal Manual.
- .3 Do not install metal flashings over flexible roof flashing until the flexible roof flashing has been inspected and approved by the Roofing Inspector. This includes curbs for roof mounted items.
- .4 Fasten metal base flashing to walls or upstands along top of flashing. Do not secure to cant strip. Form lapped corner joints. Extend rolled edge of base flashing approximately 25 mm on to roof from toe of cant, and rest on top of roof surface.
- .5 Do not use exposed fastening unless indicated, or concealed fastening is not possible. Locations and methods shall be approved by Departmental Representative.
- .6 Provide underlay under sheet metal.

- .1 Secure in place and lap joints 100 mm.
- .7 Counterflash bituminous flashings at intersections of roof with vertical surfaces and curbs.
 - .1 Flash joints using standing seams forming tight fit over hook strips, as detailed.
- .8 Lock end joints and caulk with sealant.
- .9 Insert metal flashing under cap flashing to form weather tight junction.
- .10 Separate metal from non-compatible metal or corrosive substrates by coating concealed surfaces, at locations of contact, with asphalt mastic or other permanent separation as recommended by manufacturer.
- .11 Underlayment: Install a slip sheet of red rosin paper and a course of polyethylene underlayment where installing stainless steel or aluminum directly on cementitious or wood substrates.
- .12 Bed flanges of Work in a thick coat of roofing cement where required for waterproof performance.
- .13 Caulk flashing at cap flashing with sealant.
- .14 Install drainage items fabricated from sheet metal, with straps, adhesives, and anchors recommended by SMACNA's Manual or the Item manufacturer, to drain roof in the most efficient manner.
- .15 Coordinate roof drain flashing installation with roof drainage system installation.
- .16 All exposed and pre-finished flashings to provide a smooth flat surface free of indentations, bumps, oil-canning, or twists, all edges, bends hard, sharp and true to line.

3.5 INSTALLATION: EAVES TROUGHS AND DOWNSPOUTS

- .1 Install eaves troughs and secure to building at 750 mm on centre with eaves trough spikes through spacer ferrules.
 - .1 Slope eaves troughs to downpipes as indicated.
 - .2 Solder or Seal joints watertight.
- .2 Install downpipes and provide goosenecks back to wall.
 - .1 Secure downpipes to wall with straps at 1800 mm on centre; minimum two straps per downpipe.
 - .2 Connect downpipes to drainage system and seal joint with plastic cement.
- .3 Install splash pans as indicated.

3.6 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.
- .3 Clean exposed metal surfaces, removing substances that might cause corrosion of metal or deterioration of finishes.

- .4 Provide final protection and maintain conditions that ensure sheet metal flashing and trim Work during construction is without damage or deterioration other than natural weathering at the time of Substantial Performance.
- .5 Leave work areas clean, free from grease, finger marks and stains.

END OF SECTION

Part 1 General

1.1 INTENT

- .1 This Section includes through penetration firestopping and smoke seal systems for penetrations through the following fire resistance rated assemblies, including both empty openings and openings containing penetrating items:
 - .1 Floors.
 - .2 Wall and partitions.
 - .3 Smoke barriers.
 - .4 Construction enclosing compartmentalized areas.
- .2 This Section includes fire resistive joint systems for the following:
 - .1 Floor-to-floor joints.
 - .2 Floor-to-wall joints.
 - .3 Head-of-wall joints.
 - .4 Wall-to-wall joints.
 - .5 Joints between perimeter edge of fire resistance rated floor assemblies and back of curtainwall system.
- .3 This specification section provides requirements for Rated Systems or systems requiring Engineered Judgements:
 - .1 Use of materials that have not been tested in a system or that are not capable of obtaining an engineered judgement will not be acceptable for use on this Project.
 - .2 Materials having only a ULC label will not be acceptable for use on this Project, unless supporting documentation is provided indicating its use in a listed assembly.

1.2 RELATED SECTIONS

- .1 Section 01 35 00 – Delegated Design
- .2 Section 03 30 00 – Cast-In-Place Concrete
- .3 Section 05 12 00 – Structural Steel Framing
- .4 Section 09 21 16 – Gypsum Board Assemblies
- .5 Division 23 Mechanical
- .6 Division 26 Electrical

1.3 REFERENCES

- .1 ASTM International Inc. (ASTM)
 - .1 ASTM E119-16a, Standard Test Methods for Fire Tests of Building Construction and Materials.
 - .2 ASTM A653/A653M-15e1, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .3 ASTM E814-13a(2017), Standard Test Method for Fire Tests of Penetration Firestop Systems.

- .4 ASTM A1008/A1008M-16, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
- .5 ASTM E1966-15, Standard Test Method for Fire-Resistive Joint Systems.
- .6 ASTM E2174-14b, Standard Practice for On-Site Inspection of Installed Fire Stops.
- .7 ASTM E2307-15b e1, Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-story Test Apparatus.
- .8 ASTM E2393-10a(2015), Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .3 National Fire Protection Agency (NFPA)
 - .1 NFPA 251, Standard Methods of Tests of Fire Endurance of Building Construction and Materials, 2006 Edition.
- .4 Underwriter's Laboratories of Canada (ULC)
 - .1 ULC Guide No. 40 U19-1998, Firestop Systems.
 - .2 CAN/ULC S101-14, Standard Methods of Fire Endurance Tests of Building Construction and Materials.
 - .3 CAN/ULC S102-11, Standard Method of Tests for Surface Burning Characteristics of Building Materials and Assemblies.
 - .4 CAN4 S114-05, Standard Method of Test for Determination of Non-Combustibility in Building Materials.
 - .5 CAN/ULC-S115-11, Standard Method of Fire Tests of Firestop Systems.
 - .6 CAN/ULC S702-14, Standard for Thermal Insulation Mineral Fibre for Buildings, Includes Amendment 1(January 2012).
 - .7 ULC S702.2-15, Mineral Fibre Thermal Insulation for Buildings, Part 2: Application Guidelines.
 - .8 List of Equipment and Materials.
- .5 Underwriters Laboratories Inc. (UL)
 - .1 ANSI/UL 1479-15, Standard for Fire Test of Through-Penetration Firestops.

1.4 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-Installation Meetings: convene pre-installation meeting one week prior to beginning work of this Section, with contractor's representative and Departmental Representative in accordance with Section 01 31 19 – Project Meetings to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.

1.5 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal.
 - .1 Not later than 30 working days following Award of Contract, submit a schedule listing surfaces or components to which firestopping and smoke-seals is to be applied, and indicating the firestopping and smoke-seals system and materials required and detailing installation.
 - .2 Where possible determine thickness to be applied from tests of assemblies identical to the assembly to be protected, conducted in accordance with ULC S-101, ASTM E119, ULI 1479, NFPA 251, and ASTM E814.
 - .3 Determine system from available engineering studies, or correspondence with the labelling agency indicating the effect of the differences on the fire separation of the assembly. Confirm acceptance of system by authorities having jurisdiction in writing.
 - .4 Where the assembly includes conditions that do not correspond to those included in any previously tested assembly and for which no relevant engineering information is available use the same system and material as would be required for a tested assembly with similar conditions.
- .2 Submit product data in accordance with Section 01 33 00 – Submittals:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Provide two copies of WHMIS MSDS - Material Safety Data Sheets in accordance with WHMIS acceptable to Labour Canada, and Health and Welfare Canada.
- .3 Quality assurance submittals: submit following in accordance with Section 01 45 00 - Quality Control.
 - .1 Test reports: in accordance with CAN-ULC-S101 for fire endurance and CAN-ULC-S102 for surface burning characteristics.
 - .1 Submit certified test reports from approved independent testing laboratories, indicating compliance of applied fire stopping with specifications for specified performance characteristics and physical properties.
 - .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .3 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, and cleaning procedures.
 - .4 Manufacturer's Field Reports: submit to manufacturer's written reports within 3 days of review, verifying compliance of Work, as described in PART 3 - FIELD QUALITY CONTROL.

1.6 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Installer: company or person specializing in fire stopping installations and approved by manufacturer.

- .2 Use materials and methods of determining required thickness of application that have the full acceptance of authority having jurisdiction.
- .3 Use materials tested to CAN/ULC-S115. Assemblies containing the materials shall be in accordance with assemblies tested and approved by agencies acceptable to authority having jurisdiction.
- .4 Source Responsibility: Obtain through penetration firestop and joint systems, for each kind of penetration and construction condition indicated, from a single source of installation responsibility.
- .5 Delegated Design Professional: Use a professional engineer, registered in the province of the Work and familiar with installations of similar scope and complexity to design firestopping and smoke seals.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
 - .3 Deliver materials to the site in undamaged condition and in original unopened containers, marked to indicate brand name, manufacturer, and ULC markings.
- .2 Storage and Protection:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.
 - .3 Use stock before its expiration date.

1.8 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for recycling in accordance with Section 01 74 21 - Waste Management and Disposal.

1.9 PROJECT CONDITIONS

- .1 Install firestopping and smoke seals materials only when the areas in which they are scheduled are closed-in and protected from dampness.
- .2 Environmental Limitations: Install firestopping and smoke seals systems when ambient or substrate temperatures are within temperature and moisture limits permitted by firestopping and smoke seals system manufacturers or when substrates are not wet due to rain, frost, condensation, or other causes.
- .3 Ventilate firestopping and smoke seals systems in accordance with manufacturer's written instructions by natural means or forced air circulation where natural means are not adequate.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturers: Subject to compliance with requirements specified in this Section, manufacturers offering products that may be incorporated into the Work include; but are not limited to, the following:
 - .1 3M Canada Inc.
 - .2 A/D Fire Protection Systems Inc.
 - .3 EZ-Path Fire Rated Pathways
 - .4 Firestop Systems Inc.
 - .5 Hilti Canada Ltd.
 - .6 Johns Manville Fire Protection Systems
 - .7 Nuco Self Seal Firestopping Products.
 - .8 Passive Fire Protection Partners Firestop Systems Inc.
 - .9 Roxtec, Preformed Fire Stopping Systems
 - .10 Specified Technologies Inc.
 - .11 Tremco Ltd.

2.2 PERFORMANCE/DESIGN CRITERIA

- .1 Delegated Design Requirements: Design firestopping and smoke seals required by the Contract Documents to withstand fire ratings indicated and in accordance with requirements of the Building Code, and as described in Section 01 35 00.
- .2 Performance Requirements: Manufacturer shall design proprietary assemblies to withstand the listed ratings in accordance with the Building Code, Underwriters Laboratories Canada, and authorities having jurisdiction, and as follows:
 - .1 Provide through penetration firestop and joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire resistance rating of assembly penetrated:
 - .1 Fire resistance rated load bearing walls, including partitions, with fire protection rated openings.
 - .2 Fire resistance rated non-load bearing walls, including partitions, with fire protection rated openings.
 - .3 Fire resistance rated floor assemblies.
 - .2 F-Rated Systems: Provide through penetration firestop systems with F-ratings indicated, as determined by ULC S115 or ASTM E814, but not less than that equalling or exceeding fire resistance rating of constructions penetrated.
 - .3 T-Rated Systems: For the following conditions, provide through penetration firestop systems with T-ratings indicated, as well as F-ratings, as determined per by ULC S115 or ASTM E814, where systems protect penetrating items exposed to potential contact with adjacent materials:
 - .1 Penetrations located outside wall cavities.
 - .2 Penetrations located outside fire resistive shaft enclosures.
 - .3 Penetrations located in construction containing fire protection rated openings.

- .4 Penetrating items larger than 100 mm diameter nominal pipe or 100 cm² in overall cross sectional area.
- .4 Firestopping and Smoke seals Systems Exposed To View: Systems exposed to view, traffic, moisture, and physical damage; provide products that after curing do not deteriorate when exposed to these conditions both during and after construction, and as follows:
 - .1 Provide moisture resistant through penetration firestop systems for piping penetrations for plumbing and wet pipe sprinkler systems.
 - .2 Provide firestopping and smoke seals systems capable of supporting floor loads involved either by installing floor plates or by other means for floor penetrations with annular spaces exceeding 100 mm in width and exposed to possible loading and traffic.
 - .3 Provide firestopping and smoke seals systems not requiring removal of insulation for penetrations involving insulated piping.
 - .4 Provide products with flame spread ratings of less than 25 and smoke developed ratings of less than 50 for firestopping and smoke seals and joint systems exposed to view.
- .5 Fire Resistance of Joint Systems: Assembly ratings and movement capabilities indicated, but with assembly ratings not less than that equalling or exceeding fire resistance rating of constructions in which joints are located.

2.3 FIRESTOPPING AND SMOKESEALS: GENERAL

- .1 Compatibility: Provide firestopping and smoke seals systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating firestopping and smoke seals systems, under conditions of service and application, as demonstrated by firestopping and smoke seals system manufacturer based on testing and field experience, and as follows:
 - .1 Service penetration assemblies: certified by ULC in accordance with ULC S115 and listed in ULC Guide No. 40 U19.
 - .2 Service penetration firestopping and smoke seals components: certified by ULC in accordance with ULC S115 and listed in ULC Guide No. 40 U19.13, under the Label Service of ULC.
 - .3 Fire resistance rating of installed firestopping and smoke seals assembly not less than the fire resistance rating of surrounding floor and wall assembly.
 - .4 Firestopping and Smoke seals at openings intended for ease of re-entry such as cables: elastomeric seal; do not use cementitious or rigid seal at such locations.
 - .5 Firestopping and Smoke seals at openings around penetrations for pipes, ductwork and other mechanical items requiring sound and vibration control: elastomeric seal; do not use a cementitious or rigid seal at such locations. Exemption to fire dampers.
- .2 Accessories: Provide components for each firestopping and smoke seals systems that are needed to install fill materials. Use only components specified by firestopping and smoke seals system manufacturer and approved by the qualified

testing and inspecting agency for firestopping and smoke seals systems indicated. Accessories include, but are not limited to, the following items:

- .1 Permanent forming, damming and backing materials, including the following:
 - .1 Slag or rock wool fibre insulation.
 - .2 Sealants used in combination with other forming, damming or backing materials to prevent leakage of fill materials in liquid state.
 - .3 Fire-rated form board.
 - .4 Fillers for sealants.
- .2 Temporary forming materials.
- .3 Substrate primers.
- .4 Collars.
- .5 Steel sleeves.
- .6 Primers: to manufacturer's recommendation for specific material, substrate, and end use.
- .7 Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.
- .8 Metal fire stop: Commercial galvanized steel, to ASTM A1008/A1008M, zinc coating 260 g/m², minimum metal core thickness 0.912 mm.
- .9 Steel Deck Moulded Flute Inserts: One piece moulded mineral fibre flute inserts, sized for steel deck profiles, for placement at top of fire rated wall assemblies:
 - .1 Acceptable material: Hilti CP777 Speed Plugs.
- .10 Labels: Peel-and-stick labels printed with the following information:
 - .1 ATTENTION: FIRE RATED ASSEMBLY. DO NOT MODIFY
 - .2 Name of firestopping manufacturer
 - .3 Names of products used
 - .4 Hour Rating of Assembly
 - .5 Manufacturers standard detail number, or Engineered Judgement identifier; ULC or cUL_{US} Number
 - .6 Date of installation
 - .7 Name of installing Subcontractor
 - .8 Contact telephone number for repair or replacement of firestopping materials.

2.4 FILL MATERIALS

- .1 General:
 - .1 Provide firestopping and smoke seals systems containing the types of fill materials indicated in the Firestopping and Smoke seals System Schedule below by reference to the types of materials described in this Article. Fill materials are those referred to in directories of the referenced testing and inspecting agencies as fill, void, or cavity materials.
 - .2 Firestopping and smoke seal systems shall be tested in accordance with ULC S115, and be comprised of asbestos-free materials and systems capable of maintaining an effective barrier against flame, smoke and

gases, and not to exceed opening sizes for which they are intended for the ratings as indicated on drawings.

- .2 Cast-in-Place Firestopping and Smoke seals Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- .3 Latex Sealants: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture.
- .4 Firestopping and Smoke seals Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrating item.
- .5 Cable Penetration Devices: Premanufactured intumescent blocks, consisting of a system of inserts and adjustable cores; or premanufactured fire rated cable pathway systems, the following products are acceptable:
 - .1 EZ-Path Fire Rated Pathway, Specified Technologies Inc.
 - .2 CP 653 Speed Sleeve, Hilti
 - .3 Intumescent Blocks CFS-BL, Hilti
 - .4 Intumescent Blocks, Roxtec.
- .6 Intumescent Composite Sheets: Rigid panels consisting of aluminum foil faced elastomeric sheet bonded to galvanized steel sheet.
- .7 Intumescent Putties: Non-hardening dielectric, water resistant putties containing no solvents, inorganic fibres, or silicone compounds.
- .8 Intumescent Spray Foam: Expanding spray-in-place intumescent foam sealant.
- .9 Intumescent Wrap Strips: Single component intumescent elastomeric sheets with aluminum foil on one side.
- .10 Mortars: Pre-packaged, dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a non-shrinking, homogeneous mortar.
- .11 Pillows/Bags: Reusable, heat expanding pillows/bags consisting of glass fibre cloth cases filled with a combination of mineral fibre, water insoluble expansion agents and fire retardant additives.
- .12 Silicone Foams: Multi-component, silicone based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.
- .13 Silicone Sealants: Moisture curing, single component, silicone based, neutral curing elastomeric sealants of grade indicated below:
 - .1 Grade for Horizontal Surfaces: Pourable (self levelling) formulation for openings in floors and other horizontal surfaces.
 - .2 Grade for Vertical Surfaces: non-sag formulation for openings in vertical and other surfaces.

2.5 ACCESSORIES

- .1 Primers: to manufacturer's recommendation for specific material, substrate, and end use.

- .2 Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.
- .3 Damming and backup materials, supports and anchoring devices: to manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.
- .4 Metal fire stop: Commercial galvanized steel, to ASTM A1008/A1008M, zinc coating 260 g/m², minimum metal core thickness 0.95 mm (20 ga.).

2.6 MIXING

- .1 For those products requiring mixing before application, comply with firestopping and smoke seals system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 EXAMINATION

- .1 Examine surfaces, components, materials to receive firestopping and smoke seals material; report any conditions which would detrimentally affect the application of the material or the proper firestopping and smoke seals of the system.
- .2 Commence Work when conditions of surfaces and the working conditions are suitable.
- .3 Where penetration sealants or caulking are required, ensure all service lines are in place, tested and approved.
- .4 Verify all proper blocking, framing (using non-combustible materials) are properly installed and prepared to receive firestopping and smoke seals. Notify Departmental Representative in writing of any deficiencies affecting the proper performance of the firestopping and smoke seals, do not proceed until deficiencies are corrected.

3.3 PREPARATION

- .1 Examine sizes and conditions of voids to be filled to establish correct thicknesses and installation of materials.
 - .1 Ensure that substrates and surfaces are clean, dry and frost free.
- .2 Prepare surfaces in contact with fire stopping materials and smoke seals to manufacturer's instructions.
- .3 Maintain insulation around pipes and ducts penetrating fire separation without interruption to vapour barrier.

- .4 Prime surfaces as required.
- .5 Mask where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.

3.4 INSTALLATION

- .1 Install fire stopping and smoke seal material and components in accordance with manufacturer's certified tested system listing.
- .2 Apply firestopping and smoke seals materials/systems to maintain the fire separations in the project as indicated on drawings.
- .3 Seal holes or voids made by through penetrations, poke-through termination devices, and unpenetrated openings or joints to ensure continuity and integrity of fire separation are maintained.
- .4 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.
- .5 Tool or trowel exposed surfaces to neat finish.
- .6 Remove excess compound promptly as work progresses and upon completion.

3.5 FIELD QUALITY CONTROL

- .1 Inspections: notify Departmental Representative when ready for inspection and prior to concealing or enclosing fire stopping materials and service penetration assemblies.
 - .1 Cut tests may be made at random by the Owner. Frequency of cut tests shall be determined by the Departmental Representative, but will not be more than 1% of total length of firestopping and smoke seals.
 - .2 Make all necessary repairs and correct all deficiencies noted after completion of cut tests.
- .2 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, twice during progress of Work at 25% and 60% complete.

3.6 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.
- .3 Remove temporary dams after initial set of fire stopping and smoke seal materials.

3.7 SCHEDULE

- .1 Design and provide through penetration firestopping and smoke seals as follows for:
 - .1 Systems with No Penetrating Items: Select one or more of the following fill materials:
 - .1 Latex sealant.
 - .2 Silicone sealant.
 - .3 Intumescent putty.
 - .4 Intumescent foam blocks or boards.
 - .5 Intumescent spray foam.
 - .2 Systems for Metallic Pipes, Conduit, or Tubing: Select one or more of the following fill materials:
 - .1 Latex sealant.
 - .2 Silicone sealant.
 - .3 Intumescent putty.
 - .4 Intumescent foam blocks or boards.
 - .5 Intumescent spray foam.
 - .3 Systems for Non-metallic Pipe, Conduit, or Tubing: Select one or more of the following fill materials:
 - .1 Latex sealant.
 - .2 Silicone sealant.
 - .3 Intumescent putty.
 - .4 Intumescent wrap strips.
 - .5 Firestopping and Smoke seals device.
 - .6 Intumescent spray foam.
 - .4 Re-enterable and Cable Managed Systems for Electrical, and Data and Communications Cables:
 - .1 Prefabricated Firestop Sleeve CP653 (Hilti)
 - .2 Preformed Intumescent Blocks CFS-BL (Hilti)
 - .3 Preformed Intumescent Blocks (Roxtec)
 - .4 Prefabricated Cable Pathways (EZ-Path)
 - .5 Systems for Electrical, and Data and Communications Cables: Select one or more of the following fill materials:
 - .1 Latex sealant.
 - .2 Silicone sealant.
 - .3 Intumescent putty.
 - .4 Silicone foam.
 - .5 Prefabricated Firestop Sleeve CP 653 (Hilti).
 - .6 Preformed Intumescent Blocks CFS-BL (Hilti)
 - .7 Preformed Intumescent Blocks (Roxtec).
 - .8 Prefabricated Cable Pathways (EZ-Path).
 - .9 Intumescent foam blocks or boards.
 - .10 Intumescent spray foam.

- .6 Systems for Cable Trays: Select one or more of the following fill materials:
 - .1 Latex sealant.
 - .2 Intumescent putty.
 - .3 Silicone foam.
 - .4 Pillows/bags.
 - .5 Intumescent foam blocks or boards.
- .7 Systems for Insulated Pipes: Select one or more of the following fill materials:
 - .1 Latex sealant.
 - .2 Intumescent putty.
 - .3 Silicone foam.
 - .4 Intumescent wrap strips.
 - .5 Intumescent foam blocks or boards.
 - .6 Intumescent spray foam.
- .8 Systems for Miscellaneous Electrical Penetrations: Select one or more of the following fill materials:
 - .1 Latex sealant.
 - .2 Intumescent putty.
 - .3 Intumescent foam blocks or boards.
 - .4 Intumescent spray foam.
- .9 Systems for Miscellaneous Mechanical Penetrations: Select one or more of the following fill materials:
 - .1 Latex sealant.
 - .2 Intumescent foam blocks or boards.
 - .3 Intumescent spray foam.
- .10 Systems for Groupings of Penetrations: Select one or more of the following fill materials:
 - .1 Latex sealant.
 - .2 Intumescent wrap strips.
 - .3 Firestopping and Smoke seals device.
 - .4 Intumescent composite sheet.
 - .5 Intumescent foam blocks or boards.
 - .6 Intumescent spray foam.
- .2 Design and provide joint firestopping and smoke seals as follows for:
 - .1 Floor-to-Floor, Fire Resistive Joint System: Provide materials to meet the following criteria:
 - .1 Assembly Rating: As indicated.
 - .2 Nominal Joint Width: As indicated.
 - .3 Movement Capabilities: Compression and extension.
 - .2 Floor-to-Wall, Fire Resistive Joint System: Provide materials to meet the following criteria:
 - .1 Assembly Rating: As indicated.

- .2 Nominal Joint Width: As indicated.
 - .3 Movement Capabilities: To be confirmed, compression, extension, or horizontal shear.
- .3 Head-of-Wall, Fire Resistive Joint System: Provide materials to meet the following criteria:
 - .1 Assembly Rating: As indicated.
 - .2 Nominal Joint Width: As indicated.
 - .3 Movement Capabilities: Compression and extension.
- .4 Wall-to-Wall, Fire Resistive Joint System: Provide materials to meet the following criteria:
 - .1 Assembly Rating: As indicated.
 - .2 Nominal Joint Width: As indicated.
 - .3 Movement Capabilities: Compression and extension.
- .3 Design and provide perimeter fire containment firestopping and smoke seals as follows for:
 - .1 Perimeter Fire Containment System: Provide materials to meet the following criteria:
 - .1 Integrity Rating: As indicated.
 - .2 Insulation Rating: As Indicated.
 - .3 Linear Opening Width: As indicated.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 03 30 00 – Cast-In-Place Concrete
- .2 Section 07 21 19 – Foamed-In-Place Insulation
- .3 Section 07 27 19 – Sheet Membrane Air and Vapour Barrier
- .4 Section 07 61 00 – Sheet Metal Roofing
- .5 Section 07 62 00 – Sheet Metal Flashing and Trim
- .6 Section 08 52 13 – Aluminum Clad Wood Windows
- .7 Section 08 80 50 – Glazing
- .8 Section 09 21 16 – Gypsum Board Assemblies
- .9 Division 23 - Mechanical

1.2 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM C919-12, Standard Practice for Use of Sealants in Acoustical Applications.
 - .2 ASTM C920-14a, Standard Specification for Elastomeric Joint Sealants.
 - .3 ASTM D2240-15, Standard Test Methods for Rubber Property, Durometer Hardness.
- .2 Department of Justice Canada (Jus)
 - .1 Canadian Environmental Protection Act, 1999 (CEPA).
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .4 South Coast Air Quality Management District (SCAQMD), California State
 - .1 SCAQMD Rule 1168-05, Adhesives and Sealants Applications.
- .5 Transport Canada (TC)
 - .1 Transportation of Dangerous Goods Act, 1992 (TDGA).

1.3 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittals.
 - .1 Submit manufacturer's printed product literature, specifications and data sheet. Indicate the following:
 - .1 Caulking compound
 - .2 Primers
 - .3 Sealing compound, each type, including compatibility when different sealants are in contact with each other.
 - .4 Manufacturers Sample Warranty
 - .2 Submit WHMIS MSDS - Material Safety Data Sheets. WHMIS MSDS acceptable to Labour Canada and Health and Welfare Canada for sealants. Indicate VOC content.

- .3 Submit manufacturer's installation instructions for each product used.
- .4 When required by Departmental Representative, submit test certificates from an approved Canadian materials testing laboratory indicating that sealants meet the requirements of the standards specified, and that the tests have been conducted in accordance with ASTM D2240.
- .2 Submit samples in accordance with Section 01 33 00 – Submittals Procedures.
 - .1 Provide colour samples of the actual sealants for approval; painted or printed colour charts are not acceptable.

1.4 QUALITY ASSURANCE

- .1 Caulking shall be performed by a caulking contractor with experience in Work of similar size and complexity.
- .2 Before performing Work of this Section, submit the names of proposed materials. If specified using Standards, indicate Qualification Number.
- .3 Compatibility: Ensure sealants are compatible with adjacent materials and are approved by manufacture for use with adjacent materials.

1.5 MOCK-UPS

- .1 Construct mock-up in accordance with Section 01 45 00 - Quality Control.
- .2 Before performing caulking work do sample applications of each type of sealant for approval. Site locations for sample applications shall be designated by Departmental Representative. Approved samples shall form standard for this project and no work of inferior quality will be allowed. Start no final work until approval of samples is given by the Departmental Representative.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, handle, store and protect materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver containers labelled and sealed, complete with written application and maintenance instructions.
- .3 Store materials in a dry heated enclosure in accordance with manufacturer's instructions.

1.7 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for recycling in accordance with Section 01 74 21 - Waste Management and Disposal.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Place materials defined as hazardous or toxic in designated containers.
- .4 Handle and dispose of hazardous materials in accordance with the CEPA, TDGA, Regional and Municipal regulations.
- .5 Unused sealant material must not be disposed of into sewer system, into streams, lakes, onto ground or in other location where it will pose health or environmental hazard.

- .6 Divert unused joint sealing material from landfill to official hazardous material collections site approved by Departmental Representative.
- .7 Empty plastic joint sealer containers are not recyclable. Do not dispose of empty containers with plastic materials destined for recycling.
- .8 Fold up metal banding, flatten, and place in designated area for recycling.

1.8 PROJECT CONDITIONS

- .1 Environmental Limitations:
 - .1 Do not proceed with installation of joint sealants under following conditions:
 - .1 When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 4.4 degrees C.
 - .2 When joint substrates are wet.
- .2 Joint-Width Conditions:
 - .1 Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
- .3 Joint-Substrate Conditions:
 - .1 Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.
 - .2 Substrate must be clean, dry, and frost free.

1.9 WARRANTY

- .1 Contractor hereby warrants that caulking work will not leak, crack, crumble, melt, shrink, run, lose adhesion or stain adjacent surfaces in accordance with General Conditions, but for three (3) years.
- .2 Provide Warranty for sealants to include in maintenance manuals as specified in Section 01 78 00 – Operations and Maintenance Data Manuals.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturers: Subject to compliance with requirements in this Section and as recommended by the manufacturer, manufacturers offering products that may be incorporated into the Work include the following:
 - .1 BASF, Sonneborn.
 - .2 Chemtron Manufacturing Ltd.
 - .3 Dow Corning Canada Inc.
 - .4 GE Silicones Limited.
 - .5 Sika Chemical of Canada Ltd.
 - .6 Tremco Ltd.

2.2 SEALANT MATERIALS

- .1 Do not use caulking that emits strong odours, contains toxic chemicals or is not certified as mould resistant in air handling units.
- .2 When low toxicity caulks are not possible, confine usage to areas which offgas to exterior, are contained behind air barriers, or are applied several months before occupancy to maximize offgas time.
- .3 Unless otherwise specified, VOC content limits of sealants shall be in accordance with SCAQMD Rule 1168 and as follows:
 - .1 Architectural Materials:
 - .1 Sealants: VOC content limit 250 g/L.
 - .2 Sealant Primers for Non-Porous Surfaces: VOC content limit 250 g/L.
 - .3 Sealant Primers for Porous Surfaces: VOC content limit 775 g/L.
 - .2 Roofing:
 - .1 Non-Membrane Related Sealants: VOC content limit 300 g/L.
 - .2 Single Ply Roofing Sealants: VOC content limit 450 g/L.
 - .3 SBS Membrane Sealant Primer: VOC content limit 500 g/L.
 - .3 All Other Applications:
 - .1 Sealants: VOC content limit 420 g/L.
 - .2 Sealant Primers: VOC content limit 750 g/L.

2.3 SEALANT MATERIAL DESIGNATIONS

- .1 Type S-1: Acrylic Latex One Part, Shore A Hardness 20, to ASTM C834.
 - .1 Acceptable materials:
 - .1 Latacalk, Chemtron.
 - .2 Sonolac, BASF Sonneborn.
 - .3 Latex 100, Tremco.
- .2 Type S-2: Silicone Sealant; mould and mildew resistant.
 - .1 To ASTM C920; type S; grade NS; class 50; use NT, G, and A.
 - .2 Acceptable materials:
 - .1 Chemtron Multiseal
 - .2 GE SCS2000
 - .3 795 Silicone, Dow Corning.
 - .4 Spectrem 2 Silicone, Tremco Inc.
 - .1 To ASTM C920; type S; grade NS; class 50; use NT, G, and A.
 - .2 Acceptable materials:
 - .1 790 Silicone, Dow Corning.
 - .2 Spectrem 1 Silicone, Tremco Inc.
 - .3 To ASTM C920; type S; grade NS; class 25; use NT, G, and A.
 - .4 Acceptable materials:
 - .1 786 Silicone, Dow Corning.
 - .2 OmniPlus, BASF Sonneborn.

- .3 SCS1700, General Electric.
- .4 Tremsil 200, Tremco Inc.
- .3 Type S-3: Silicone Sealant; general construction and air-seal sealant.
 - .1 To ASTM C920: type S; grade NS; class 25; use NT, M, G, A, O.
- .4 Type S-4: Silicone Sealant; structural glazing.
 - .1 To ASTM C920: type S; grade NS; class 25; use NT, A, G, O.
 - .2 Acceptable materials:
 - .1 995 Silicone, Dow Corning.
 - .2 Proglaze SSG, Tremco Inc.
 - .3 SSG4000, General Electric.
- .5 Type S-5: Acoustical Sealant; interior, non-skimming, non-hardening, simple component synthetic rubber sealant.
 - .1 Acceptable materials:
 - .1 Acoustical Sealant, Tremco
 - .2 Metaseal, Chemtron.
- .6 Type S-6: Multi-component polyurethane sealant; chemical curing, exterior wall sealant.
 - .1 To ASTM C920: type M; grade NS; class 50; use T, NT, M, A, O.
 - .2 Acceptable materials:
 - .1 Dymeric, Tremco.
 - .2 Sikaflex 2c NS, Sika.
 - .3 Sonolastic NP 2, BASF Sonneborn.
 - .4 Thioplast 400, Chemtron
- .7 Type S-7: One-component polyurethane sealant; non-sag, for general construction.
 - .1 To ASTM C920: type S; grade NS; class 25; use NT, M, A, O.
 - .2 Acceptable materials:
 - .1 Dymonic FC, Tremco Inc
 - .2 Multiflex, Chemtron.
 - .3 Masterseal NPI, BASF
 - .4 Sikaflex 1a, Sika.
 - .5 Mapeflex P1, MAPEI Inc
 - .6 Pourthane NS, W.R. Meadows Canada
- .8 Type S-8: Horizontal joint sealant; two component, self-levelling.
 - .1 To ASTM C920: type M; grade P; class 25; use T, M, O.
 - .2 Acceptable materials:
 - .1 Sikaflex 2c SL, Sika.
 - .2 Sonolastic SL 2, BASF Sonneborn.
 - .3 THC-901, Tremco Inc

- .9 Type S-9: One part moisture curing, low modulus polyurethane sealant for sealing joints in level and slightly slope surfaces conforming to ASTM C920, type S, grade P, class 50, use T, M, A,O, MC-1-25-B-N.
 - .1 Acceptable materials:
 - .1 Sonolastic SL 1, BASF Sonneborn.
 - .2 Vulkem 45 SSL, Tremco Inc
- .10 Type S-10: Control joint sealant: two-component, epoxy-urethane, self-levelling, load bearing saw cut or preformed control joints.
 - .1 Acceptable materials:
 - .1 Loadflex, Sika.
 - .2 Planiseal Rapid Joint 15, MAPEI Inc.
 - .3 Rezi-Weld Flex with Pourthane NS, WR Meadows
- .11 Type S-11: One-component polyurethane sealant; medium-modulus, non-sag, low-VOC, UV stable.
 - .1 To ASTM C920: type S; grade NS; class 50; use NT, T, M, A, O, I.
 - .2 Acceptable materials:
 - .1 Dymonic 100, Tremco Inc.
 - .2 Multiflex, Chemtron
 - .3 Vulkem 116, Mameco

2.4 ACCESSORIES

- .1 Preformed Compressible and Non-Compressible back-up materials that are non-staining, compatible with joint substrate, sealants, primers, and other joint fillers, and are approved for applications indicated by sealant manufacturer based on site experience and laboratory testing.
 - .1 Rod Type Sealant Backings:
 - .1 ASTM C1330, Type C (closed cell material with a surface skin), Type O (open cell material) or Type B (bi-cellular material with a surface skin).
 - .2 Use any of the preceding types, as approved in writing by joint sealant manufacturer for joint application indicated.
 - .3 Size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
 - .4 Non-adhering to sealant, to maintain two sided adhesion across joint.
 - .2 High Density Foam.
 - .1 Extruded closed cell polyvinyl chloride (PVC), extruded polyethylene, closed cell, Shore A hardness 20, tensile strength 140 to 200 kPa, extruded polyolefin foam, 32 kg/m³ density, or neoprene foam backer, size as recommended by manufacturer.
 - .3 Bond Breaker Tape.
 - .1 Polyethylene bond breaker tape or other tape recommended by sealant manufacturer which will not bond to sealant.
- .2 Preformed Sealants

- .1 Preformed Silicone Sealant System: Manufacturer's standard system consisting of pre-cured low modulus silicone extrusion, in sizes to fit joint widths indicated, combined with a neutral curing silicone sealant for bonding extrusions to substrates:
 - .1 Acceptable materials:
 - .1 Dow Corning Corporation; 123 Silicone Seal.
 - .2 GE Silicones; UltraSpan US1100.
 - .3 Tremco; Spectrem Ez Seal.
- .3 Primer: Non-staining type as recommended by sealant manufacturer.
- .4 Joint Cleaner: Non-corrosive solvent type recommended by sealant manufacturer for applicable substrate materials.

2.5 COLOURS

- .1 Colours: To match adjacent materials, as selected by Departmental Representative, from manufacturer's standard colour range.

2.6 SEALANT SELECTION

- .1 Where no specified type of sealant is shown or specified, choose one of the sealants specified in this Section appropriate for its location.
- .2 Make sealant selections consistent with manufacturer's recommendations.
- .3 Use acrylic sealant Type S-1 only on the interior and only in situations where little or no movement can occur.
- .4 Use mould & mildew resistant silicone sealant Type S-2 for non-moving joints in washrooms and kitchens. Do not use on floors.
- .5 Use silicone general construction sealant Type S-3 or Type S-6 and S-7 for all joints, interior and exterior, where no other specific sealant type specified.
- .6 Use structural glazing silicone Type S-4 for sealing glass, interior and exterior.
- .7 Use acoustical sealant Type S-5 and air seal sealant Type S-3 only where they will be fully concealed and only where no constant or consistent air pressure difference will exist across the joint.
- .8 Use multi-component sealant type S-6, primed penetration element surfaces other than concrete, for mechanical and electrical service penetrations in concrete foundation walls.
- .9 Use multi-component sealant Type S-8 for horizontal joint sealant of plaza, floors and decks, exterior areas only, subject to pedestrian and vehicular traffic.
- .10 Use polyurethane, semi-self levelling sealant Type S-9 for in expansion joints in sidewalks, plazas, floors and other pedestrian and vehicular horizontal surfaces with slopes up to 6%.
- .11 Use control joint sealant S-10 as filler for interior, horizontal saw cut or preformed control joints where joints are subject to load bearing conditions.
- .12 Use sealant S-11 for sealing exterior holes and penetrations around pipes and other services passing through concrete foundations and requiring greater movement capability.

Part 3 Execution

3.1 PROTECTION

- .1 Protect installed Work of other trades from staining or contamination.

3.2 INSPECTION

- .1 Carefully inspect surfaces, materials to receive sealants and verify they are physically capable of retaining sealant bond.
- .2 Verify that fillers and backing provided under other Sections properly installed.

3.3 SURFACE PREPARATION

- .1 Prepare surfaces in accordance with manufacturer's instructions.
- .2 Examine joint sizes and conditions to establish correct depth to width relationship for installation of backup materials and sealants.
- .3 Maintain workmanship of highest quality in accordance with best trade practice.
- .4 Ensure that joint forming materials are compatible with sealant.
- .5 Clean bonding joint surfaces of harmful matter substances including dust, rust, oil grease, and other matter which may impair Work. Wire brush loose materials and other foreign matter which might impair adhesion of sealant.
- .6 Use air stream to blow out dirt and water from crevices.
- .7 Ensure joint surfaces are dry and frost free
- .8 Prime all porous material (e.g. wood, masonry, concrete, ceramic or paver tile, etc).
- .9 Prime other joints when recommended by manufacturer. Use a brush that will reach all parts of the joints. Mask adjoining surfaces with tape prior to priming to prevent staining.

3.4 PRIMING

- .1 Where necessary to prevent staining, mask adjacent surfaces prior to priming and caulking.
- .2 Prime sides of joints in accordance with sealant manufacturer's instructions immediately prior to caulking.

3.5 BACKUP MATERIAL

- .1 Use backer rod as specified, to limit depth of sealant and to act as bond breaker at back of joint.
- .2 Install joint filler to achieve correct joint depth and shape, with approximately 30% compression.
- .3 Where depth of joint does not permit the use of backer rod apply paper masking tape to back of joint to act as bond breaker.
- .4 Ensure that no joints are formed which are bonded on adjacent sides where there is any possibility of movement.

3.6 MIXING

- .1 Mix materials in strict accordance with sealant manufacturer's instructions.

3.7 APPLICATION

- .1 Apply sealant in strict accordance with manufacturer's recommendations.
- .2 For joints where movement is possible, apply backer rod to achieve a joint depth of one half the joint width but not less than 9 mm; for joints larger than 25 mm use a depth of 13 mm
- .3 Use pressure gun fitted with suitable nozzle. Use sufficient pressure to fill voids and joints solid.
- .4 Form surface of sealant smooth, free from ridges, wrinkles, sags, or air pockets and imbedded impurities. Neatly tool surface to a slight concave appearance.
- .5 Tool sealants to achieve air tight joints. Use wet tools as required.
- .6 Ensure bead is solid, filling entire space between sides and bedding material, exerting sufficient pressure to obtain maximum bond, by allowing sealant to bulge out in advance of nozzle.
- .7 Apply sealant within recommended temperature ranges. Consult manufacturer when sealant cannot be applied within recommended temperature range.
- .8 Seal perimeters of hollow metal door frames on both sides.
- .9 Seal control joints in gypsum board and stucco, and junctures between interior partitions with exterior walls.
- .10 Seal window and door frames around the inside perimeter, so that an airtight seal is obtained, as indicated on drawings.
- .11 Seal joints in floors and walls and around service and mechanical and electrical fixture penetrations.
- .12 Seal at all locations where dissimilar material meet.
- .13 Curing
 - .1 Cure sealants in accordance with sealant manufacturer's instructions.
 - .2 Do not cover up sealants until proper curing has taken place.

3.8 CLEAN UP

- .1 Clean adjacent surfaces immediately and leave Work neat and clean.
- .2 Remove excess and droppings, using recommended cleaners as work progresses.
- .3 Remove masking tape after initial set of sealant.
- .4 On porous surfaces allow sealant to cure overnight, and remove excess by light wire brushing.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 07 21 19 – Foamed-In-Place Insulation
- .2 Section 07 92 00 – Sealants
- .3 Section 08 11 16 – Aluminum Doors and Frames
- .4 Section 08 14 16 – Flush Wood Doors
- .5 Section 08 71 00 – Door Hardware
- .6 Section 08 80 50 – Glazing
- .7 Section 09 91 00 – Painting

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A653/A653M-15e1, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM A780/A780M-09(2015), Standard Practice for Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings.
 - .3 ASTM A879/A879M-12(2017), Standard Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface
 - .4 ASTM A924 / A924M-16ae1, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
 - .5 ASTM B29-14, Standard Specification for Refined Lead.
 - .6 ASTM B749-14, Standard Specification for Lead and Lead Alloy Strip, Sheet and Plate Products.
 - .7 ASTM C553-13, Specification for Mineral Fiber Blanket Insulation for Commercial and Industrial Applications
 - .8 ASTM C578-16, Specification for Rigid, Cellular Polystyrene Thermal Insulation
 - .9 ASTM C591-16, Specification for Un-Faced Pre-formed Rigid Cellular Polyisocyanurate Thermal Insulation
 - .10 ASTM C592-16, Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)
 - .11 ASTM C1289-16a, Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
 - .12 ASTM D1622/D1622M-14, Standard Test Method for Apparent Density of Rigid Cellular Plastics.
 - .13 ASTM D4726-15, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Exterior-Profile Extrusions Used for Assembled Windows and Doors.
 - .14 ASTM D6386-16a, Standard Practice for Preparation of Zinc (Hot Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting.

- .15 ASTM D7396-14, Standard Guide for Preparation of New, Continuous Zinc-Coated (Galvanized) Steel Surfaces for Painting.
- .2 Builders Hardware Manufacturers Association (BHMA)
 - .1 BHMA A156.16-2013, Auxiliary Hardware.
- .3 Canadian Standards Association (CSA International)
 - .1 CAN4-S106-M80(R1985), Standard Method for Fire Tests of Window and Glass Block Assemblies
 - .2 CSA-G40.20-13/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel, Includes Update No. 1 (2014).
 - .3 CSA W47.1-09(R2014), Certification of companies for fusion welding of steel, Includes Update No. 3 (2011), Update No. 5 (2012), Update No. 6 (2013).
 - .4 CSA W59-13, Welded Steel Construction (Metal Arc Welding), Includes Update No. 1 (2014).
- .4 Canadian Steel Door Manufacturers' Association (CSDMA)
 - .1 CSDMA, Guide Specification for Installation and Storage of Hollow Metal Doors and Frames, 2012.
 - .2 CSDMA, Recommended Specifications for Commercial Steel Doors and Frames, 2006.
 - .3 CSDMA, Selection and Usage Guide for Commercial Steel Doors, 2009.
- .5 National Fire Protection Association (NFPA)
 - .1 NFPA (Fire) 80, Standard for Fire Doors and Other Opening Protectives, 2016 Edition.
 - .2 NFPA (Fire) 252, Fire Tests of Door Assemblies, 2012 Edition.
- .6 South Coast Air Quality Management District (SCAQMD), California State
 - .1 SCAQMD Rule 1113-11, Architectural Coatings.
 - .2 SCAQMD Rule 1168-05, Adhesives and Sealants Applications.
- .7 The Society for Protective Coatings (SSPC)
 - .1 SSPC-PS 12.0-1-02, One Coat Zinc-Rich Painting System.
 - .2 SSPC-PS Guide 12.00, Guide to Zinc-Rich Coating Systems.
- .8 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC S104-15, Standard Method for Fire Tests of Door Assemblies.
 - .2 CAN/ULC S105-16, Standard Specification for Fire Door Frames Meeting the Performance Required by CAN/ULC-S104.
 - .3 CAN/ULC-S701-11, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.
 - .4 CAN/ULC-S702-14, Standard for Thermal Insulation Mineral Fibre for Buildings, Includes Amendment 1 (January 2012).
 - .5 CAN/ULC-S704-11, Standard for Thermal Insulation, Polyurethane and Polyisocyanurate Boards, Faced.

1.3 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittals:
 - .1 Submit manufacturer's printed product literature, specifications and data sheets for each type of door and frame specified.
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittals:
 - .1 Indicate general construction of each type of door and frame, configurations, material, material thickness, jointing methods, mortises, reinforcements, anchors, arrangement of hardware, fire ratings, finish and special features.
 - .2 Reference door and frame types to Door Schedule. Indicate door numbers where applicable.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for cleaning and maintenance of finishes for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 QUALITY ASSURANCE

- .1 Manufacturer/Fabricator: member in good standing of the Canadian Steel Door and Frame Manufacturer's Association.
- .2 Installer: Use installers who are experienced with the installation of hollow metal doors and frames of similar complexity and extent to that required for the Project.
- .3 Provide fire labelled frame products for those openings requiring fire protection ratings, as scheduled:
 - .1 List by nationally recognized agency having factory inspection service and construct as detailed in Follow-up Service Procedures/Factory Inspection Manuals issued by listing agency to individual manufacturers.
 - .2 Fabricate all rated doors, frames and screens to labelling authority standard.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and as follows:
 - .1 Receive and store materials as recommended by materials manufacturer.
 - .2 Adequately protect surfaces from damage during moving, handling and storage.

1.7 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 – Waste Management and Disposal.

Part 2 Products

2.1 PERFORMANCE/DESIGN CRITERIA

- .1 Perform work in accordance with CSDMA, Recommended Specifications for Commercial Steel Doors and Frames, except as otherwise specified herein.

- .2 Design exterior frame assembly to accommodate to expansion and contraction when subjected to minimum and maximum surface temperature of -35 degrees C to 35 degrees C.
- .3 Maximum deflection for exterior steel entrance screens under wind load of 1.2 kPa not to exceed 1/175th of span.
- .4 Steel fire rated doors and frames: Label and list fire rated doors and frames by an organization accredited by the Standards Council of Canada in conformance with CAN4-S104 and CAN4-S105 for ratings indicated. Fire labels must be factory applied by the manufacturer.
- .5 Be responsible for securing approval from authorities having jurisdiction for materials, fabrication and installation of fire rated oversized door and frame assemblies

2.2 MATERIALS

- .1 Steel:
 - .1 Doors and Frames: coated steel sheets to ASTM A924/M924; coating designation to ASTM A653/A653M: Commercial Steel (CS), Type B, ZF180; stretcher levelled.
 - .2 Exterior doors and frames and Interior High Humidity Area: coated steel sheets to ASTM A924/M924; coating designation to ASTM A653/A653M: Commercial Steel (CS), Type B, ZF180 galvanized, stretcher levelled.
- .2 Nominal Base Metal Thickness Requirements:
 - .1 Frames: refer to frame fabrication requirements specified in this section.
 - .2 Doors: refer to door fabrication requirements specified in this section.
 - .3 Hardware Reinforcement for Doors and Frames: Carbon steel, welded in place, prime painted, to the following minimum nominal thicknesses:

Hardware Reinforcement	Door (mm)	Frame (mm)
Mortise Hinge:	3.51	3.51
Mortise or Bored Lock or Deadbolt:	1.98	1.98
Flush or Surface Bolt Front:	1.98	1.98
Surface or Concealed Closer:	2.74	2.74
Strike Reinforcements:	1.98	1.98
Hold Open Arm:	1.98	1.98
Electronic Hardware Reinforcements:	1.98	1.98
Pull Plates and Bars:	1.30	1.30
Mortar Box:	--	0.84
Surface Exit Devices:	1.98	1.98
Door Surface Hardware Reinforcements:	1.30	1.30
Frame surface hardware reinforcements:	2.74	2.74
Notes: Provide guard boxes to protect mortised cut-outs from spray applied insulation, fully sealed.		

- .3 Door Core Materials
 - .1 Honeycomb: Structural small cell 25 mm maximum. kraft paper honeycomb:
 - .1 Weight: 36.3 kg/ream minimum.
 - .2 Density: 16.5 kg/m³ minimum.
 - .3 Sanded to required thickness.
 - .2 Polystyrene: Rigid extruded, closed cell insulation, fire retardant treated meeting the requirements of ULC S701, Type 4, minimum thermal resistance RSI 0.8/25 mm thickness.
 - .3 Polyurethane: rigid, cellular type, board, conforming to ASTM D1622, or foamed-in-place, 1.8 pound per cubic foot (29 kilograms per cubic meter) density minimum, containing no urea formaldehyde resins.

2.3 ADHESIVES

- .1 Honeycomb cores and steel components: heat resistant, spray grade, resin reinforced neoprene/rubber (polychloroprene) based, low viscosity, contact cement.
 - .1 Adhesive: maximum VOC content 50 g/L to SCAQMD Rule 1168.
- .2 Polystyrene and polyurethane cores: heat resistant, epoxy resin based, low viscosity, contact cement.
- .3 Interlocking Edge Seam Adhesive: fire resistant, resin reinforced polychloroprene, high viscosity, sealant/adhesive.

2.4 PRIMER

- .1 Touch-up primer: to ASTM A780/A780M and SSPC-PS 12.01.
 - .1 Maximum VOC limit 50 g/L to GC-03.

2.5 PAINT

- .1 Prepare surfaces for field painting to ASTM D6386 and ASTM D7396.
- .2 Field paint steel doors and frames in accordance with Section 09 91 00 - Painting. Protect weatherstrips from paint. Provide final finish free of scratches or other blemishes.
 - .1 Maximum VOC emission level 50 g/L to GS-11 and to SCAQMD Rule 1113.

2.6 ACCESSORIES

- .1 Door silencers (bumpers): Grey rubber, to ANSI/BHMA A156.16 Type 6-180; three silencers on strike jambs of single door frames; two silencers on heads of double door frames; screw fastener applied. Stick on bumpers are not acceptable.
- .2 Floor anchors: 3.5 mm minimum adjustable floor clip angles with 2 holes for anchorage to floor.
- .3 Exterior Top Caps: Rigid polyvinylchloride (PVC) extrusion in accordance with CAN/CGSB 41-GP-19Ma.

- .4 Fabricate glazing stops as formed channel, minimum 16 mm height, accurately fitted, butted at corners and fastened to frame sections with counter-sunk oval head sheet metal screws.
- .5 Make provisions for glazing as indicated and provide necessary glazing stops.
 - .1 Provide removable glazing beads for use with glazing tapes and compounds and secured with countersunk stainless steel screws.
 - .2 Design exterior glazing stops to be tamperproof.
- .6 Metallic paste filler: to manufacturer's standard.
- .7 Fasteners: tamperproof type 304 stainless steel screws with countersunk flat head.
- .8 Labels for fire doors and door frame: brass plate, riveted to door and door frame.
- .9 Sealant: Section 07 92 00 – Joint Sealants.
 - .1 Maximum VOC limit 250 g/L to SCAQMD Rule 1168.
- .10 Glazing: Section 08 80 50 – Glazing.

2.7 FABRICATION GENERAL

- .1 Welded construction: assemble units by welding in accordance with CSA W59 to produce a finished unit square, true and free of distortion. Welding shall be undertaken only by a fabricator fully approved by the Canadian Welding Bureau to the requirements of CSA W47.1.
- .2 Make provisions in doors and frames to suit requirements of trade or section providing electrically operated hardware or security devices. Provide removable plates or knock outs for electrical contacts. Provide junction boxes on security door frames as required for door strikes, mag locks and door contacts. Ensure frames arrive on site prepared for wiring.
- .3 Fabricate galvanized steel channels to reinforce frames and screens as required for size, and for fire protection rating requirements. Extend reinforcements from floor to structure above. Design top connection to accommodate structural deflection. Conceal reinforcements in frames and screens.

2.8 FRAMES AND SCREENS FABRICATION: GENERAL

- .1 Fabricate frames in accordance with CSDMA specifications.
- .2 Accurately form frames to profiles indicated. Construct frames straight and free from twist or warp.
- .3 Exterior frames: 1.98 mm minimum welded thermally broken type construction. 50 mm face standard frame profile, throat and frame width to suit wall construction.
- .4 Interior frames: 1.6 mm minimum for single doors; 1.98 mm for frames with opening width in excess of 1220 mm; welded type construction. 50 mm face standard frame profile, throat and frame width to suit wall construction. Knock-down frames are not allowed.
- .5 Blank, drill, reinforce and tap frames to receive mortised, templated hardware, security, and electrical devices, using templates provided by finish hardware supplier. Reinforce frames for installation of closers. For transportation, install stiffener plates or two angle spreaders where required to prevent bending of

- frame and to maintain alignment when setting. Weld reinforcement in place. Remove prior to installation.
- .6 Provide removable portion of stop and frame where required for overhead concealed door closers, properly connected to frame, and prepare for attachment of closer prior to shipment.
 - .7 Protect mortised cutouts with steel guard boxes.
 - .8 Manufacturer's nameplates on frames and screens are not permitted.
 - .9 Conceal fastenings except where exposed fastenings are indicated.
 - .10 Provide factory-applied touch up primer at areas where zinc coating has been removed during fabrication.
 - .11 Partition Screens:
 - .1 Fabricate metal screens to profiles indicated.
 - .2 Supply jamb and mullion extensions and anchors required to secure screens to structure or framing provided under other Sections. Fabricate anchorage to prevent transfer of load from support framing to the screens when deflection of structure occurs.
 - .3 Provide concealed reinforcement for screens to receive handrails.
 - .4 Provide closely fitted steel glass stops where required. Mitre corners. Drill and countersink fasteners symmetrically at 150 mm o.c. Screw stops in place.
 - .12 Provide fire labelled frames for those openings requiring fire protection ratings, as scheduled on Drawings.

2.9 FRAME ANCHORAGE

- .1 Provide appropriate anchorage to floor and wall construction.
- .2 Where frames terminate at finished floor, supply floor plates for anchorage to slab. Check depth of extension of finished floor to structural slab and provide jamb extension anchorage as required. Provide 50 mm minimum adjustment
- .3 Locate wall anchors immediately above or below each hinge reinforcement on the hinge jamb, and directly opposite on the strike jamb. Provide three anchors per jamb for frames up to 2300 mm. Add one anchor per jamb for each additional 760 mm or fraction thereof in frame height.
- .4 Locate anchors for frames in existing openings not more than 150 mm from top and bottom of each jambs and intermediate at 660 mm on centre maximum.

2.10 FRAMES: WELDED TYPE

- .1 Welding in accordance with CSA W59.
- .2 Cut frame mitres accurately and weld on inside of frame profile. Fill frame corners, exposed surface depressions and butted joints with air drying paste filler. Sand to a smooth uniform finish. Touch up damaged galvanized finish with zinc rich primer.
- .3 Cope accurately and securely weld butt joints of mullions, transom bars, centre rails and sills.

- .4 Grind welded joints and corners to a flat plane, fill with metallic paste and sand to uniform smooth finish.
- .5 Securely attach floor anchors to inside of each jamb profile.
- .6 Weld in 2 temporary jamb spreaders per frame to maintain proper alignment during shipment.

2.11 DOOR FABRICATION GENERAL

- .1 Fabricate steel doors rigid, neat in appearance, and free from defects including warp and buckle; 45 mm thickness of types and sizes indicated on drawing, and as follows:
 - .1 Door faces of all steel doors shall be fabricated without visible seams, free of scale, pitting, coil brakes, buckles and waves.
 - .2 Form edges true and straight with minimum radius suitable for thickness of steel used.
 - .3 Bevel lock and hinge edges 3 mm in 50 mm; confirm requirement with builder's hardware or door swing that could dictate a different bevel.
 - .4 Top and bottom of doors shall be provided with inverted, recessed, nominal 1.60 mm steel end channels, welded to each face sheet at 150 mm O/C.
 - .5 Equip exterior doors with factory installed flush PVC top caps. Equip fire labelled exterior doors with factory installed flush steel top caps.
 - .6 Provide fire labelled doors for those openings requiring fire protection ratings, as indicated on Drawings.
 - .7 Fabricate doors with the following clearances:
 - .1 Clearance between door and frame and between meeting edges of doors swinging in pairs shall not exceed 3 mm
 - .2 Clearance between the bottom of door and floor shall not exceed 19 mm or as required to accommodate specified hardware
 - .3 Clearance between bottom of door and a raised non-combustible sill in accordance with NFPA 80
 - .4 Clearance between bottom of door and nominal surface of combustible floor coverings in accordance with NFPA 80
- .2 Fabricate doors with longitudinal edges locked seam and spot welded. Seams: not visible, grind welded joints to a flat plane, fill with metallic paste filler and sand to a uniform smooth finish. Bevel both stiles of single doors 1 in 16.
- .3 Exterior Doors: Flush, lock seam construction, insulated doors fabricated in accordance with CAN/CGSB 82.5, and as follows:
 - .1 Face Sheets: Minimum 1.60 mm base steel sheet thickness.
 - .2 Insulation Stiffened Core: Insulated and sound deadened with polystyrene or polyisocyanurate at choice of manufacturer core laminated under pressure to each face sheet.
- .4 Interior Doors: Flush, lock seam construction, hollow steel doors fabricated in accordance with CSDMA Manufacturing Specifications for Doors and Frames, and as follows:
 - .1 Face sheets: Minimum 1.30 mm base steel sheet thickness.

- .2 Stiffened and sound deadened with honeycomb core laminated under pressure to each face sheet.
- .5 Fire Rated Doors: Flush, lock seam construction, hollow steel doors fabricated in accordance with CAN4 S104 and NFPA 80, and as follows:
 - .1 Face sheets: Minimum nominal 1.60 mm base steel sheet thickness.
 - .2 Stiffened and sound deadened with honeycomb core laminated under pressure to each face sheet.
 - .3 Equip pairs of fire labelled doors with minimum 2.74 mm steel surface mounted flat bar astragal, welded to door face; plug welded on face and stitch welded to butt edge of door.
 - .4 Labelled by Underwriters Laboratories of Canada, ITS/Warnock Hersey, or other testing laboratory approved by the authority having jurisdiction.

2.12 THERMALLY BROKEN FRAMES

- .1 Thermal break: rigid polyvinylchloride extrusion, to ASTM D4726.
- .2 Fabricate thermally broken frames separating exterior parts from interior parts with continuous interlocking thermal break.
- .3 Insulate exterior frame components with polyurethane insulation as indicated in Section 07 21 19.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 EXAMINATION

- .1 Verify condition and dimensions of previously installed work upon which this Section depends. Report defects to Departmental Representative. Commencement of work means acceptance of existing conditions

3.3 INSTALLATION GENERAL

- .1 Install fire rated doors and frames in accordance with requirements of NFPA 80.
- .2 Install doors, frames and accessories in accordance with reviewed shop drawings, ANSI A250.11, CSDMA Guide Specification for Installation and Storage of Hollow Metal Doors and Frames, manufacturer's data, and as specified in this Section.

3.4 FRAME INSTALLATION

- .1 Door Frames:
 - .1 Remove temporary spreaders before installing door frames, leaving exposed surfaces smooth and undamaged.
 - .2 Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set; limit of acceptable frame

- distortion 2 mm out of plumb measured on face of frame, maximum twist corner to corner of 3 mm; align horizontal lines in final assembly.
- .3 Brace frames rigidly in position until adjacent construction is complete; install wooden spreaders at third points of frame rebate to maintain frame width, install centre brace to support head of frames 1200 mm and wider in accordance with ANSI A250.1; do not use temporary metal spreaders for bracing of frames 1.
- .4 Place frames before construction of enclosing walls and ceilings, except for frames located in existing walls or partitions allowing for deflection of adjacent construction to ensure that structural loads are not transmitted to frames, and as follows:
 - .1 Check and correct opening width and height, squareness, alignment, twist and plumb as frames are installed in accordance with CSDMA Recommended Dimensional Standards for Commercial Steel Doors and Frames.
 - .2 Metal Stud Partitions: Provide a minimum of three wall anchors per jamb for frames up to 2150 mm high and 1 additional anchor for each 600 mm over 2150 mm high; install adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb; attach wall anchors to studs with screws.
 - .3 Remove wooden braces after frames are securely fastened or attached to adjacent construction.
- .5 Install glazing materials and studded door silencers.
- .6 Do not site weld unless approved by Departmental Representative in writing for the specific screen.
- .7 For frames over 1220 mm in width, provide vertical support at the centre of head.
- .2 Window Frames:
 - .1 Installation of borrowed lights is same as for door frames.
 - .2 Site assemble large borrowed lights to provide true and even alignment with flush butt hairline jointing, all fasteners concealed.
 - .3 Site weld only when approved by Departmental Representative in writing for the specific location.
 - .4 Align all horizontal rails in final assembly.
 - .5 Install sealant and back-up materials
- .3 Frame Tolerances: Install frames to tolerances listed in ANSI A250.11, and as follows:
 - .1 Squareness: Maximum 1.6 mm measured across opening between hinge jam and strike jamb.
 - .2 Plumbness: Maximum 1.6 mm measured from bottom of frame to head level.
 - .3 Alignment: Maximum 1.6 mm measured offset between face of hinge jamb and strike jamb relative to wall construction.
 - .4 Twist: Maximum 1.6 mm measured from leading edge of outside frame rabbet to leading edge of inside frame rabbet.
- .4 Install door silencers.

- .5 Caulk perimeter of frames between frame and adjacent material.
- .6 Maintain continuity of air barrier and vapour retarder.

3.5 DOOR INSTALLATION

- .1 Fit hollow metal doors accurately in frames within clearances required for proper operation; shim as necessary for proper operation.
- .2 Install hardware in accordance with hardware templates and manufacturer's instructions and Section 08 71 00 - Door Hardware.
- .3 Provide even margins between doors and jambs and doors and finished floor and thresholds as follows.
 - .1 Hinge side: 1.0 mm.
 - .2 Latchside and head: 1.5 mm.
 - .3 Finished floor, top of carpet: 6 mm; 13 mm at openings in non-fire rated separations where undercuts are indicated.
- .4 Adjust operable parts for correct clearances and function.

3.6 FINISH REPAIRS

- .1 Touch-up areas where galvanized coating has been removed or damaged with primer.
- .2 Fill exposed frame anchors and surfaces with imperfections with metallic paste filler and sand to a uniform smooth finish.

3.7 GLAZING

- .1 Install glazing for doors and frames in accordance with Section 08 80 50 - Glazing.

3.8 ADJUSTING AND CLEANING

- .1 Adjust doors for smooth and balanced door movement.
- .2 Clean doors, frames [and screens].

3.9 FIELD PAINTING

- .1 Prepare surfaces for field painting, to ASTM D6386 and ASTM D7396.
- .2 Field painting: refer to Section 09 91 00 Painting. Protect weatherstrips from paint. Provide final finish, free of scratches or other blemishes.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 05 50 00 – Metal Fabrications.
- .2 Section 06 10 00 – Rough Carpentry.
- .3 Section 07 21 16 – Fibrous Insulation.
- .4 Section 07 27 19 – Sheet Membrane Air and Vapour Barrier.
- .5 Section 07 92 00 – Sealants
- .6 Section 08 71 00 – Door Hardware - General.
- .7 Section 08 80 50 – Glazing
- .8 Section 26 05 20 – Wire and Box Connectors - 0-1000 V.
- .9 Section 26 05 32 – Outlet Boxes, Conduit Boxes and Fittings.
- .10 Section 26 05 34 – Conduits, Conduit Fastenings and Conduit Fittings.
- .11 Section 26 27 26 – Wiring Devices.
- .12 Division 26: Electrical connections for security systems and sensors.

1.2 REFERENCES

- .1 Aluminum Association (AA)
 - .1 DAF 45-03, Designation System for Aluminum Finishes.
- .2 American Architectural Manufacturers Association (AAMA)
 - .1 AAMA 501-15, Methods of Test for Exterior Walls.
 - .2 AAMA 609-15, Cleaning and Maintenance Guide for Architecturally Finished Aluminum.
 - .3 AAMA 611-14, Voluntary Specification for Anodized Architectural Aluminum.
 - .4 AAMA 1503-09, Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.
 - .5 AAMA AFPA—1-15, Anodic Finishes/Painted Aluminum.
 - .6 AAMA CW-RS-1-12, The Rain Screen Principle and Pressure Equalized Wall Design.
 - .7 AAMA RPC-00, Rain Penetration Control: Applying Current Knowledge.
- .3 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM A653/A653M-15e1, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy Coated (Galvannealed) by the Hot Dip Process.
 - .2 ASTM B209-14, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - .3 ASTM B221/B221M-14, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - .4 ASTM B429/B429M-10e1, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.

- .5 ASTM C920-14, Standard Specification for Elastomeric Joint Sealants.
- .6 ASTM E330-14, Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
- .4 American Society of Heating Refrigeration and Air-Conditioning (ASHRAE)
 - .1 ASHRAE 90.1-2013, Energy Standard for Buildings Except Low-rise Residential Buildings.
- .5 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-12.1-M90, Tempered or Laminated Safety Glass.
- .6 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-G40.20/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .2 CAN/CSA G164-M92 (R2003), Hot Dip Galvanizing of Irregularly Shaped Articles.
 - .3 CSA W47.1-09, Certification of Companies for fusion Welding of Steel, Includes Update No. 3 (2011), Update No. 5 (2012), Update No.6 (2013).
 - .4 CSA W47.2-11, Certification of Companies for Fusion Welding of Aluminum, Includes Update No.1 (2011), Update No.2 (2012).
 - .5 CSA W59-13, Welded Steel Construction (Metal Arc Welding), Includes Update No. 1 (2014).
 - .6 CSA W59.2-M1991 (R2013), Welded Aluminum Construction.
- .7 The Society for Protective Coatings (SSPC)/National Association of Corrosion Engineers (NACE International)
 - .1 Surface Preparation Guidelines:
 - .1 SSPC-SP COM Surface Preparation Commentary for Steel and Concrete Substrates.
 - .2 SSPC-PS Guide 12.00, Guide to Zinc-Rich Coating Systems.
- .8 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC S702-09AM1, Standard for Thermal Insulation Mineral Fibre for Buildings, Includes Amendment 1 (January 2012).

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-Installation Meetings: convene pre-installation meeting one week prior to beginning work of this Section and on-site installation, with contractor's representative and Departmental Representative in accordance with Section 01 31 19 – Project Meetings to:
 - .1 Verify project requirements.
 - .2 Review manufacturer's installation instructions and warranty requirements.

1.4 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittals:
 - .1 Submit manufacturer's printed product literature, specifications and data sheets.
 - .2 Submit WHMIS MSDS - Material Safety Data Sheets. WHMIS MSDS acceptable to Labour Canada and Health and Welfare Canada. Indicate VOC's for caulking materials during application and curing.
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittals:
 - .1 Indicate materials and profiles and provide full-size, scaled details of components for each type of door and frame. Indicate:
 - .1 Interior trim and exterior junctions with adjacent construction.
 - .2 Junctions between combination units.
 - .3 Elevations of units.
 - .4 Core thicknesses of components.
 - .5 Type and location of exposed finishes, method of anchorage, number of anchors, supports, reinforcement, and accessories.
 - .6 Location of caulking.
 - .7 Each type of door system including location.
 - .8 Arrangement of hardware and required clearances.
 - .2 Submit catalogue details for each type of door and frame illustrating profiles, dimensions and methods of assembly.
- .3 Manufacturer's Instructions:
 - .1 Submit manufacturer's installation instructions.
- .4 Manufacturers' Field Reports: Submit two copies of manufacturers field reports.

1.5 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for cleaning and maintenance of aluminum finishes for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.6 QUALITY ASSURANCE

- .1 Qualifications: Fabricator shall have experience in fabrication and erection of metal entrances of similar sizes, shapes and finishes to units required for this project and shall have ample facilities to produce, furnish and supply units as required for installation without delay to Work.
- .2 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
- .3 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Storage and Protection:

- .1 Apply temporary protective coating to finished surfaces. Remove coating after erection. Do not use coatings that will become hard to remove or leave residue.
- .2 Leave protective covering in place until final cleaning of building.

1.8 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Waste Management and Disposal.

1.9 WARRANTY

- .1 Provide manufacturers written guarantee, signed and issued in name of Owner, to replace following items for defective material and workmanship for time stated from date of Substantial Performance:
 - .1 Framing, panels and glazing: failure of performance requirements; 2 years.
 - .2 Sealed glass units: misting, dusting and seal failure; 10 years.
 - .3 Sealants, caulking: failure to maintain seal; 2 years.
 - .4 Aluminum brakeshapes: oil canning and delaminating; 2 years.
 - .5 Finishes: failure specified finishes not attributable to normal weathering: 20 years.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturers: Subject to compliance with requirements specified in this Section and as established by the Basis-of-Design Materials, manufacturers offering products that may be incorporated into the Work include; but are not limited to, the following:
 - .1 A & D Prevost Inc.
 - .2 Alumicor Limited.
 - .3 CRL/U.S. Aluminum
 - .4 Ferguson Glass Western Ltd. (Engineered Aluminum Products Inc.)
 - .5 Kawneer Canada Ltd.

2.2 SYSTEM DESCRIPTION

- .1 Design Criteria.
 - .1 Design frames and doors in exterior walls to:
 - .1 Accommodate expansion and contraction within service temperature range of -35 to +35 degrees C.
 - .2 Limit deflection of mullions to maximum 1/175th of clear span when tested to ASTM E330 under wind load of 1.2 kpa. Submit certificate of tests performed.
 - .3 Air Infiltration: For single acting offset pivot or butt hung entrances in the closed and locked position, the test specimen shall be tested in accordance with ASTM E283 at a pressure differential of

6.24 psf (300 Pa) for single doors and 1.567 psf (75 PA) for pairs of doors. A single 915 mm x 2134 mm entrance door and frame shall not exceed 0.50 cfm per square foot. A pair of 1830 mm x 2134 mm entrance doors and frame shall not exceed 1.0 cfm per square foot.

- .2 Size glass thickness and glass unit dimensions to limits.
- .3 Provide continuous air barrier and vapour retarder through door system. Primarily in line with inside pane of glass and heel bead of glazing compound.

2.3 MATERIALS

- .1 Aluminum extrusions: Aluminum Association alloy AA6063-T5, T6, or T54 anodizing quality.
- .2 Sheet aluminum: Alloy 1100, F temper, 3 mm minimum thickness exposed sheet finished to match frames as specified.
- .3 Steel reinforcement: to CAN/CSA-G40.20/G40.21, grade 300 W, shop painted with zinc chromate primer, thickness as required to support imposed loads and in no case less than 4.8 mm thick.
- .4 Fasteners: to ASTM A167, stainless steel, type 304 or cadmium plated steel, finished to match adjacent material and selected to prevent galvanic action with fastened materials of suitable size to sustain imposed loads.
- .5 Door bumpers: black neoprene, entrance manufacturer's standard.
- .6 Door bottom seal: operable and automatic door seal of anodized extruded aluminum frame and vinyl weather seal, recessed in door bottom, closed ends.
- .7 Isolation coating: bituminous paint, acid and alkali resistant asphaltic paint in accordance with MPI Architectural Painting Specification Manual approved product listing.
- .8 Glazing materials: refer to Section 08 80 50.
- .9 Glass Gaskets: As specified under Section 08 80 50.
- .10 Spacers for glazing, backpans/aluminum spandrels to be full length, purpose made, aluminum channels.
- .11 Sealant: Including primer, joint filler, as specified in Section 07 92 00.
- .12 Thermal separator: Polyvinylchloride, 50 Shore A durometer hardness +5.
- .13 Fibrous insulation: Refer to Section 07 21 16.

2.4 ALUMINUM FRAMES

- .1 Exterior Aluminum Frame: thermally broken to profiles indicated and as required to performance requirements, but not less than 3 mm thick unless otherwise shown, suitable alloy and proper temper for extruding and adequate structural characteristics; and suitable for finishing as specified. 64 mm x 186 mm using mullion profile 64 mm x 133 mm with cap 64 mm x 19 mm. Provide 127 mm mullion profile for interior glazing only.
 - .1 Acceptable material:
 - .1 2500 Series, Alumicor.
 - .2 2500 Series, Desa.

- .3 100 Series, Engineered Aluminum Products Inc. (EAP).
- .4 1600 System 1, Kawneer.
- .5 3250 Series, CRL US Aluminum
- .2 Interior Frame Profile with 50 mm Sight Line: Nominal 50 mm x 100 mm, centre glazed, and as follows:
 - .1 Acceptable materials:
 - .1 1800/800 Series, Alumicor
 - .2 F200 Series, Desa Glass
 - .3 Tri-Fab 450, Kawneer Canada Inc.
 - .4 450 Series, CRL US Aluminum

2.5 ALUMINUM SWING DOORS

- .1 Aluminum doors fabricated of rigid extruded rectangular aluminum tube cut and welded together and with internal reinforcing at corners. Some manufacturer's may have to modify their standard system to meet the minimum bottom rail size noted for standard door construction.
- .2 Doors 57.2 mm thickness with 88.9 mm top rail and 165.1 mm bottom rail, standard interlock, meeting and 54 mm jamb stiles with sealed unit safety glass, door sizes as scheduled on drawings. Door adapter shall be thermally broken.
 - .1 Acceptable materials:
 - .1 360 Insulclad, Kawneer.
 - .2 350TB Series, Desa Glass
 - .3 400A Insulated Series, Alumicor.
 - .4 400T Series, CRL/US Aluminum
 - .5 2250, A & D Prevost Inc.

2.6 HARDWARE MATERIALS

- .1 The following list of materials is intended to establish product quality and acceptable materials. Product substitutions will be considered when submitted in accordance with Section 01 62 00 – Substitutions and Product Options.

Hardware Item	Acceptable Manufacturers	Acceptable Materials
Locklatch: Lock function appropriate to room type listed in Schedule.	Adams Rite	4510
Cylinders	AR CAM	985 x 29 mm
Automatic Entrance Operator (All systems shall include switching network for cardreader device, door locking interface, and push button actuator)		
	Besam	Power Swing
	Horton	4000 LE
	Gyro Tech	GT-500 x SA1
	Horton	4000 LE
	Hunter	HA-8

Hardware Item	Acceptable Manufacturers	Acceptable Materials
	Keanne Munro Stanley	360 Series Magic-Swing Visible LS
Closers: Aluminum doors	Arrow LCN Norton Sargent	7000 4040 7500 350
Pull	Kawneer	Classic CO-12
Push	Kawneer	Classic CP-12
Hinges	NRP	114 x 144
Floor Stop Dome type to suit floor finish	Standard Metal Hagar Gallery	S100/S102 243F/241F 218/200
Additional miscellaneous hardware as indicated in Hardware Schedule shall be commercial quality, matching hardware requirements established by named products above.		

- .2 Panic Exit Devices: In accordance with BHMA A156.3, Grade 1, listed and labelled by a testing and inspecting agency acceptable to Authorities Having Jurisdiction for panic protection, type and function as listed in Section 08 71 00.
- .3 Weather Stripping: Manufacturer's standard replaceable components, and as follows:
 - .1 Compression Type: Moulded neoprene meeting ASTM D2000 or moulded PVC meeting ASTM D 2287.
 - .2 Sliding Type: Wool, polypropylene, or nylon woven pile with nylon fabric or aluminum-strip backing meeting AAMA 701.
- .4 Weather Sweeps: Manufacturer's standard exterior door bottom sweep with concealed fasteners on mounting strip.
- .5 Provide all hardware of each type from one manufacturer.
- .6 Keying as indicated in Section 08 71 00.

2.7 ALUMINUM FINISHES

- .1 Clear Anodized: Exposed aluminum surfaces shall be Aluminum Association (AA) Architectural Class I, AA-M12C22A41, clear anodized matching Kawneer #14.
- .2 Unexposed aluminum: Mill finish.

2.8 STEEL FINISHES

- .1 Finish steel clips and reinforcing steel with zinc coating to CSA G164.

2.9 ALUMINUM BRAKESHAPES

- .1 Shop laminate sheet aluminum to treated plywood backing over rigid insulation to profiles and sizes as indicated; Conceal plywood backing with aluminum.
- .2 Brake aluminum to profiles prior to painting and/or anodizing (except clear anodized anodic oxide finish).
- .3 Finish: To match window exterior exposed aluminum.

2.10 FABRICATION GENERAL

- .1 Doors and framing to be by same manufacturer.
- .2 Fit and assemble all Work in the shop insofar as practical
- .3 Reinforce members and joints with steel plates, bars, rods or angles for rigidity and strength as needed to fulfill performance requirements. Use concealed stainless steel fasteners for jointing which cannot be welded.
- .4 Fit joints tightly and secure mechanically.
- .5 Provide cut-outs and integral reinforcing as required to receive hardware.
- .6 Separate unlike metals or alloys with a heavy coating of bituminous paint, separator gaskets or slip gaskets as required to prevent galvanic action.
- .7 Provide weepholes in glazing recess and an airseal at interior glassline.
- .8 Glazing to be held by pressure plate system with snap-on covers.
- .9 Glass fabrication specified under Section 08 80 50.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.2 INSPECTION

- .1 Inspect Work and conditions affecting the Work of this Section. Proceed only after deficiencies, if any, have been corrected.
- .2 Construct flashings built-in or provided by others integrate with system to divert moisture to exterior.
- .3 Verify that reglets, anchor blocks or inserts required to receive system are correctly located and installed.
- .4 Verify that anchors and setting or installing components provided by this Section to others for installation are properly located and installed.
- .5 Verify that building air and vapour retarding membranes can be sealed to entrance units to maintain building envelope system integrity.

3.3 PREPARATION

- .1 Obtain all dimensions from the job site.
- .2 Provide data, dimensions and components, anchors and assemblies to be installed by others in proper time for installation.

3.4 INSTALLATION

- .1 Install in accordance with the manufacturer's written instructions and the contract documents, plumb, true, level and rigid.
- .2 Conceal all anchors and fitments. Exposed heads of fasteners not permitted. All joints in exposed work to be flush hairline butt joints.
- .3 Use anchors that will permit sufficient adjustment for accurate alignment. Make allowance for deflection of building structure.
- .4 Build in and provide any supplementary reinforcing and bracing required by assembly loads and deflections.
- .5 Secure Work adequately to structure in a manner not restricting thermal and wind movement.
- .6 Correctly locate and install flashings, deflectors and weep holes and verify proper drainage of moisture to exterior.
- .7 Maintain alignment with adjacent Work.
- .8 Isolate aluminum surfaces from adjacent dissimilar materials and metals with coatings of bituminous paint.
- .9 Verify all stops, gaskets, splines, seals, etc. are perfectly aligned and ready to receive glazing and insulated panels as specified herein.
- .10 Install glazing to details and instruction, using material specified.
- .11 When a full mullion is used at perimeter framing, glazing, pocket may be stabilized for pressure plate with a block of rigid insulation.
- .12 Glazing stops, snap covers and pressure plates shall be of a continuous length from corner to corner, and be fitted at corners.
- .13 All preformed tapes or gaskets shall be of a continuous length corner to corner and shall be cut over length to prevent stretching. Joints, splices and corners shall be mitred and sealed.
- .14 Clean all contact surfaces of glazing with solvent and wipe dry. Verify all glazing channels are clean, true to line, and free of dirt or debris and that weep and drainage vents are open.
- .15 Rest glazing on setting blocks at 1/4 points.
- .16 Seal full perimeter of door lights to provide and maintain the designed air/vapour/thermal barrier integrity and weather tightness.
- .17 Pack fibrous insulation or foamed-in-place insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
- .18 Hang doors using hardware scheduled. Adjust as required for proper operation.
- .19 Install weatherstrip to provide positive contact.

- .20 Install sealants and back-up materials in strict accordance with manufacturer's written instruction.
- .21 Make cut-outs for hardware ie: card readers and push buttons.

3.5 CLEANING

- .1 Perform cleaning of aluminum components in accordance with AAMA 609.1 - Voluntary Guide Specification for Cleaning and Maintenance of Architectural Anodized Aluminum.
- .2 Perform cleaning as soon as possible after installation to remove construction and accumulated environmental dirt.
- .3 Clean aluminum with damp rag and approved non-abrasive cleaner.
- .4 Remove traces of primer, caulking, epoxy and filler materials; clean doors and frames.
- .5 Clean glass and glazing materials with approved non-abrasive cleaner.
- .6 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 08 11 13 - Steel Doors and Frames
- .2 Section 08 71 00 - Door Hardware - General
- .3 Section 08 80 50 - Glazing

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)
 - .1 ANSI A208.1-2009, Particleboard.
- .2 Architectural Woodwork Manufacturers Association of Canada (AWMAC)
 - .1 AWMAC/AWI Architectural Woodwork Standards, Most Recent Edition.
- .3 Canadian Hardwood Plywood and Veneer Association (CHPVA)
 - .1 CHPA Official Grading Rules for Rotary Cut Face Veneers.
- .4 Canadian Standards Association (CSA International)
 - .1 CSA O115-M1982(R2001), Hardwood and Decorative Plywood.
- .5 Environmental Choice Program (ECP)
 - .1 UL 2761 (formerly CCD-045), Sealants and Caulking Compounds.
 - .2 UL 2762 (formerly CCD-046), Adhesives.
- .6 National Fire Protection Association (NFPA)
 - .1 NFPA Fire 80-15, Standard for Fire Doors and Other Opening Protectives, 2016 Edition.
 - .2 NFPA Fire 252-16, Standard Methods of Fire Tests of Door Assemblies, 2012 Edition.
- .7 National Lumber Grades Authority (NLGA)
 - .1 Standard Grading Rules for Canadian Lumber 2010.
- .8 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC S104-15, Standard Method for Fire Tests of Door Assemblies.
 - .2 CAN/ULC S105-16, Standard Specification for Fire Door Frames Meeting the Performance Required by CAN/ULC-S104.
- .9 Window & Door Manufacturers Association (WDMA):
 - .1 ANSI/WDMA 1.S.1A-13, Industry Standard for Interior Architectural Wood Flush Doors
 - .2 ANSI/WDMA 1.S.6A-13, Industry Standard for Interior Architectural Wood Stile and Rail Doors

1.3 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittals.
 - .1 Submit manufacturer's printed product literature, specifications and data sheet.

- .2 Submit two copies of WHMIS MSDS - Material Safety Data Sheets. Indicate VOC's:
 - .1 For caulking materials during application and curing.
 - .2 For door materials and adhesives.
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittals.
 - .1 Show construction and materials used in cores, size and species of edge strip, thickness and species of cross-banding, and thickness and species of face veneer.
 - .2 Show details of openings and mouldings for glazing.
 - .3 Indicate locations, sizes and types of all doors to be supplied reference to the Door and Hardware Schedule.
 - .4 Indicate elevation of each kind of door, details of construction, location and extent of hardware blocking, [fire ratings], requirements for factory finishing and other pertinent data.
 - .5 Include finishing specifications for doors to receive factory-applied finish.
 - .6 Include certifications as might be required to show compliance with specifications.

1.4 QUALITY ASSURANCE

- .1 Fabricate doors in accordance with the AWMAC/AWI Architectural Woodwork Standards, Section 9 - Doors, Custom grade.
- .2 Manufacturer Qualification: Manufacturer specializing in products in this section who have experience and are a member in good standing of the Architectural Woodwork Manufacturers Association of Canada (AWMAC).
- .3 Regulatory Requirements:
 - .1 Wood fire rated doors: labelled and listed by an organization accredited by Standards Council of Canada.
- .4 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
- .5 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Delivery and Acceptance Requirements:
 - .1 Deliver doors and panels to minimize storage on site and when site conditions conform to requirements for storage.
- .2 Storage and Protection:
 - .1 Store and handle doors and panels in accordance with AWMAC requirements, and as follows:
 - .1 Protect doors from dampness. Arrange for delivery after work causing abnormal humidity has been completed.
 - .2 Store doors in well ventilated room, off floor, in accordance with manufacturer's recommendations.

- .3 Protect doors from scratches, handling marks and other damage.
- .4 Store doors away from direct sunlight.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for recycling in accordance with Section 01 74 21 - Waste Management and Disposal.

1.7 WARRANTY

- .1 Provide warranty issued in the name of the Owner stating that doors are warranted against defects in materials and workmanship for the life of the original installation.
- .2 Warranty to include coverage for reasonable amount to remove, replace, refinish, and re-hang doors that do not meet accepted AWMAC tolerances.

Part 2 Products

2.1 FIRE RATED WOOD DOORS

- .1 Wood doors: tested in accordance with CAN/ULC-S104 or NFPA 252 to achieve rating as scheduled.
 - .1 Face panels: species to match non-rated doors.
 - .2 Edges: to match face panels.
 - .3 Metal label secured to hinge edge of door.
 - .4 Finish: clear.

2.2 FLUSH SOLID CORE DOORS

- .1 Flush wood doors: solid core to AWMAC Standard.
- .2 Dry lumber to an average moisture content of between 6 and 12% maximum at time of manufacture.
- .3 Construction:
 - .1 Solid particleboard core having minimum density of 449 kg/m³ in accordance with ANSI A208.1 and as follows:
 - .1 Stiles and Rails: Structural Composite Lumber (SCL) bonded to core to AWMAC Manual standards and as follows:
 - .1 Side Stiles: SCL with 16 mm hardwood edge, to match face veneers; no finger jointed materials permitted.
 - .2 Top and Bottom Rails: SCL with 16 mm soft wood cap.
 - .2 Reinforcement: with wood lock blocks
 - .3 Construction: 5-ply
 - .4 Use: interior.
 - .2 Door cores to be fully bonded and abrasive planed or sanded prior to laminating faces to core materials.
 - .3 Door Thickness: 45 mm overall.
- .4 Duty Rating: Heavy Performance Grade in accordance with WDMA I.S. 1-A.

- .1 AWMAC Edge Type D-Solid Wood Edge Band; crossband edge covered and veneer face edge showing
- .5 Face Panels:
 - .1 Decorative Wood Veneer: AWMAC quality grade and hardwood species, supplied from same source, clear and bright in colour with minimum of pin knots, mineral or sugar streaks, no open defects, heartwood, or wild grain, and minimal colour variation between flitches, meeting the requirements for Hardwood Plywood Veneer Association (HPVA) quality grade and hardwood species as indicated.
 - .1 Grade: Custom, with Grade A faces.
 - .2 Species: as directed.
 - .3 Cut: as directed
 - .4 Match between Veneer Leaves: Book match.
 - .5 Finish: Factory finished as indicated below for transparent finishes.
 - .6 Minimum Thickness: 0.50 mm.
 - .7 Paired doors to have matching veneer pattern for uniform appearance.

2.3 ACCESSORIES

- .1 Adhesive: Type I (waterproof)
- .2 Metal Door Frames: Refer to Section 08 11 13 – Steel Doors and Frames.
- .3 Transom and Side Panels: to match materials and construction of adjacent doors and as follows:
 - .1 Meeting edges of doors and transom panels to be square.
 - .2 Veneer of doors and transom panels to be end and colour matched.
- .4 Glass: Clear tempered safety glass as specified under Section 08 80 50.
- .5 Glazing Stops: Solid hardwood with mitred corners, to match veneers.

2.4 FABRICATION

- .1 Fabricate doors in accordance with AWS section 9.
- .2 Fabricate fire rated doors to sizes required to allow clearances specified in NFPA 80 and as follows. Coordinate with door frames and door hardware to be utilized.
 - .1 Between door and jamb or head: 3.2 mm maximum.
 - .2 Between meeting edges of paired doors: 3.2 mm maximum.
 - .3 Between door and noncombustible finished floor: 19.05 mm maximum.
 - .4 Between door and floor coverings: 12.7 mm maximum.
 - .5 Between door and raised noncombustible sill or threshold: 9.5 mm maximum.
- .3 Vertical edge strips to match face veneer.
- .4 Prepare doors for glazing. Provide hardwood species to match face veneer and glazing stops with mitred corners.

- .5 Doors shall be pre-fitted, bevelled and machined at the factory for all mortise hardware items as per templates and approved hardware schedules provided.
- .6 Bevel vertical edges of single acting doors 3 mm in 50 mm on lock side and 1.5 mm in 50 mm on hinge side.
- .7 Radius vertical edges of double acting doors to 60 mm radius.

2.5 FINISHES

- .1 Factory finish doors in accordance with AWS Section 5 – Finishing, System 9 UV-Curable, Acrylated Epoxy, Polyester or Urethane as a minimum.
- .2 Paint in accordance with Section 09 91 00 – Painting.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.2 INSTALLATION

- .1 Unwrap and protect doors in accordance with AWMAC.
- .2 Install labelled fire rated doors in accordance with NFPA 80 and to provide specified clearances. Do not site modify labeled fire rated doors.
- .3 Install doors and hardware in accordance with manufacturer's printed instructions and AWMAC.
- .4 Adjust hardware for correct function.
- .5 Install glazing in accordance with Section 08 80 50 - Glazing.
- .6 Install stops.
- .7 Secure transom and side panels by means of stops, concealed fasteners or countersunk screws concealed by means of wood plugs matching panel in grain and colour.

3.3 ADJUSTMENT

- .1 Re-adjust doors and hardware just prior to completion of building to function freely and properly.

3.4 CLEANING

- .1 Perform cleaning as soon as possible after installation to remove construction and accumulated environmental dirt.
- .2 Remove traces of primer, caulking; clean doors and frames.
- .3 Clean glass and glazing materials with approved non-abrasive cleaner.
- .4 On completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 This Section includes conventionally glazed aluminum curtain walls installed as stick built systems consisting of; but not limited to, the following:
 - .1 Fixed, clear low emissivity (Low E) sealed glass units.
 - .2 Full length pressure plate system
 - .3 Dry glazed from exterior with screw on pressure plate, keyed-in neoprene gasket and thermal break.
 - .4 Internal weep drainage and compartmentalization in accordance with established design principles for rain screen and pressure equalization in curtain wall systems.
 - .5 Snap-On covers.
- .2 Drawings contain details that suggest directions for solving some of the major design requirements; these details can be developed further by the Contractor provided that the final installation adheres to aesthetic criteria established by the drawings and specified dimensions with all elements in planes as drawn, maintaining their relationships with all other building elements.

1.2 RELATED SECTIONS

- .1 Section 01 35 00 – Delegated Design.
- .2 Section 05 50 00 – Metal Fabrications: Metal fabricated attachment devices, framed openings, and structural support framing for sloped glazing.
- .3 Section 06 10 00 – Rough Carpentry.
- .4 Section 07 21 16 – Fibrous Insulation.
- .5 Section 07 25 19 – Foam-In-Place Insulation.
- .6 Section 07 27 13 – Modified Bituminous Air and Vapour Barrier.
- .7 Section 07 92 00 - Sealants.
- .8 Section 08 11 16 – Aluminum Doors and Frames.
- .9 Section 08 80 50 – Glazing.
- .10 Section 09 21 16 – Gypsum Board Assemblies.

1.3 REFERENCES

- .1 Aluminum Association (AA)
 - .1 AA DAF-45-2003(R2009), Designation System For Aluminum Finishes.
- .2 American Architectural Manufacturers Association (AAMA).
 - .1 AAMA/WDMA/CSA 101/I.S.2/A440-11 - NAFS - North American fenestration standard/Specification for windows, doors, and skylights
 - .2 AAMA CW-DG-1-96, Aluminum Curtain Wall Design Guide Manual.
 - .3 AAMA CW-10-12, Care and Handling of Architectural Aluminum From Shop to Site.
 - .4 AAMA CW-11-85, Design Wind Loads for Buildings and Boundary Layer Wind Tunnel Testing.

- .5 AAMA CWG-1-89, Installation of Aluminum Curtain Walls.
- .6 AAMA T1R-A1-04, Sound Control for Fenestration Products.
- .7 AAMA 501-15, Methods of Test for Exterior Walls.
 - .1 AAMA 501.1, Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure.
 - .2 AAMA 501.5, Test Method for Thermal Cycling of Exterior Walls.
- .8 AAMA 503-14, Voluntary Specification for Field Testing of Metal Storefronts, Curtain Wall and Sloped Glazing Systems.
- .9 AAMA 611-14, Voluntary Specifications for Anodized Finishes Architectural Aluminum.
- .10 AAMA 612-17, Voluntary Specifications, Performance Requirements, and Test Procedures for Combined Coatings of Anode Oxide and Transparent Organic Coatings on Architectural Aluminum.
- .11 AAMA 2603-17, Voluntary Specification Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.
- .12 AAMA 2604-17, Voluntary Specification Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.
- .3 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A36/A36M-14, Standard Specification for Carbon Structural Steel.
 - .2 ASTM A123/A123M-15, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - .3 ASTM A480/A480M-16b, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
 - .4 ASTM A653/A653M-15e1, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .5 ASTM B209-14, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - .6 ASTM B221-14, Standard Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - .7 ASTM C165-07(2012), Standard Test Method for Measuring Compressive Properties of Thermal Insulations.
 - .8 ASTM C794-15a, Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants.
 - .9 ASTM C1087-16, Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems.
 - .10 ASTM E90-09(2016), Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
 - .11 ASTM E283-04(2012), Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

- .12 ASTM E330/E330M-14, Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls, by Uniform Static Air Pressure Difference.
- .13 ASTM E331-00(2016), Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform Static Air Pressure Difference.
- .14 ASTM E413-16, Classification for Rating Sound Insulation.
- .15 ASTM E547-00(2016), Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Cyclic Static Air Pressure Difference.
- .16 ASTM E1105-15, Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference.
- .4 Canadian General Standards Board (CGSB).
 - .1 CAN/CGSB 12.1-2017, Tempered or Laminated Safety Glass.
 - .2 CAN/CGSB 12.3-M91(R2017), Flat, Clear Float Glass.
 - .3 CAN/CGSB 12.4-M91(R2017), Heat Absorbing Glass.
 - .4 CAN/CGSB 12.8-97 AMEND, Insulating Glass Units.
- .5 Canadian Standards Association (CSA International).
 - .1 CSA A440-11(R2016), NAFS – North American Fenestration Standard/Specification for Windows, Doors, and Skylights, includes Update No. 1 (2014)
 - .2 CAN/CSA A440-00/A440.1-00 (R2005), A440-00, Windows / Special Publication A440.1-00, User Selection Guide to CSA Standard A440-00, Windows. Includes Update NO. 1 (2000), Update No. 2 (2006), Update No. 3 (2006).
 - .3 CSA A440S1-17, Canadian Supplement to AAMA/WDMA/CSA 101/I.S.2/A440,NAFS # North American Fenestration Standard/Specification for windows, doors, and skylights.
 - .4 CSA-G40.20-13/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steels, Includes Update No. 1 (2014).
 - .5 CSA-S136-12, North American Specification for the Design of Cold-Formed Steel Structural Members, Includes Update No. 1 (2009), Update No. 2 (2010).
 - .6 CSA-S157-05/S157.1-05 (R2015), Strength Design in Aluminum / Commentary on CSA S157-05, Strength Design in Aluminum, Includes Update No. 1 (2007), Update No. 3 (2009).
 - .7 CSA W47.1-09 (2014), Certification of companies for fusion welding of steel.
 - .8 CSA W47.2-11 (R2015), Certification of companies for fusion welding of aluminum, Welded Aluminum Construction.
 - .9 CSA W59-13, Welded Steel Construction (Metal Arc Welding), Includes Update No. 1 (2014), Update No. 3 (2015), Update No. 4 (2015).
- .6 Environmental Choice Program (ECP).

- .1 UL2761 (formerly CCD-45) 2011, Sustainability for Sealants and Caulking Compounds.
- .2 UL 2768 (formerly CCD-47) 2011, Sustainability for Architectural Surface Coatings.
- .3 UL 2760 (formerly CCD-48) 2011, Sustainability for Surface Coatings: Recycled Water-borne.
- .7 Society for Protective Coatings (SSPC).
 - .1 SSPC - Paint 20, Zinc Rich Coating (Type I inorganic and Type II organic).
 - .2 SSPC - Paint 25, Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel.

1.4 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-installation Meetings: Convene pre-installation meeting one week prior to beginning work of this Section and on-site installation, with Contractor, Departmental Representative, installer, manufacturer's representative in accordance with Section 01 31 19 – Project Meetings to:
 - .1 Verify project requirements, substrate conditions, manufacturer's installation instructions, and manufacturer's warranty requirements;
 - .2 Review location and alignment of vertical and horizontal elements as they relate to the aesthetic criteria indicated on the Drawings, and the technical requirements indicated on the shop drawings.
- .2 Coordination: Coordinate installation of system with work specified in other Sections to ensure proper placement and installation of vapour barrier, insulation and flashing in order that air, vapour and thermal barrier of building is intact and moisture will be diverted to the exterior, and as follows:
 - .1 Coordinate installation of sealants so that ambient and surface temperatures are greater than 5°C from time of application until sealants have cured.
 - .2 Coordinate connection of curtain wall system structural connections at floor slabs to vertical members.
 - .3 Coordinate Work of this Section with installation of firestopping, installation of ductwork to rear of louvres, and adjacent components or materials.

1.5 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittals:
 - .1 Submit manufacturer's printed product literature, specifications and technical data sheet.
 - .2 Submit product data indicating construction details, material descriptions, dimensions of individual components and profiles, finishes, anchorage and fasteners, glass and infill, and internal drainage details.
 - .3 Provide two copies of WHMIS MSDS - Material Safety Data Sheets.

- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittals:
 - .1 Submit shop drawings, signed and sealed by the delegated design engineer, detailing fabrication and assembly of glazed aluminum curtain wall systems clearly indicating all construction details including; but not limited to, the following:
 - .1 Fully dimensioned layouts for positioning of secondary support members and anchorage of tie-back devices to structures;
 - .2 Large scale details of members and materials, of brackets and anchorage devices and of connection and jointing details;
 - .3 Fully dimensioned layouts for positioning of brackets and anchorage devices to structures;
 - .4 Dimensions, gauges, thicknesses;
 - .5 Type, size and spacing of fastening devices;
 - .6 Glazing details;
 - .7 Air/vapour barrier details, acoustic control details, aluminum alloy and temper designations, metal finishing specifications and other pertinent data and information;
 - .8 Internal drainage;
 - .9 Show details of connecting work of this section with work of adjacent sections.
- .3 Submit samples in accordance with Section 01 33 00 – Submittals:
 - .1 Submit samples of materials for Departmental Representative's verification of specified finishes including; but not limited to, the following:
 - .1 300 mm x 450 mm for sheets, plates and glass;
 - .2 300 mm long for extrusions and formed or rolled shapes;
 - .3 300 mm long for tapes and gaskets;
 - .4 150 mm long for sealants;
 - .5 Samples shall fully represent physical and chemical properties, finish, and colours of materials to be supplied.
 - .2 Submit a sample of each finish hardware item that is to be supplied under this section.
 - .3 Submit two samples 610 x 610 mm in size illustrating window frame section, insulation, vapour barrier, glass, spandrel panels, vents and sealant.
- .4 Information Submittals: Provide the following:
 - .1 Delegated Design Submittals: Submit letters of commitment and compliance in accordance with Section 01 35 00 – Delegated Design Submittals as follows:
 - .1 Provide Letter of Commitment in conjunction with shop drawings, signed and sealed by the professional engineer required by the Work of this Section indicating the following are designed to the intent of the Building Code:
 - .1 Curtain wall connections to building structure.
 - .2 Curtain wall reinforcement.
 - .3 Deflection of members.

- .4 Glass thickness as it relates to glass area.
- .2 Provide Letter of Compliance, signed and sealed by the professional engineer required by the Work of this Section indicating that connections, reinforcement and deflection criteria, and glass thickness of installed system is in compliance with the intent of the Building Code and reviewed shop drawings before declaration of Substantial Performance.
- .2 Calculations:
 - .1 Submit complete design study calculations, certified by a professional engineer licensed to design structures and registered in the jurisdiction of the Place of the Work, including pertinent information affecting design, wind reactions, shading effects and failure probability for thermal glazing units and spandrel panels, to Departmental Representative as evidence of compliance with design criteria, prior to manufacture.
 - .2 Pressure equalized rain screen (PER) design: calculations to include the following:
 - .1 Pressure equalization during exposure to the design wind pressures and gusts;
 - .2 PER design provides pressure equalization of the cavity compartments within 0.5 seconds.
- .3 Sealant Data:
 - .1 Submit product information on the sealants to be used, complete with all recommendations and installation instructions, including cleaning and priming procedures.
 - .2 Submit sealant manufacturer's test reports on adhesion to metal and glass production samples tested in accordance with ASTM C794, 7 day cure and 7 day water submersion, tensile strength at 100% elongation and bite size of sealants.
 - .3 Submit sealant manufacturer's statement and test data indicating that stress on the sealants when exposed to maximum load does not exceed 38 kPa and a safety factor of 5:1.
 - .4 Submit sealant manufacturer's compatibility statement that all materials in contact with the sealants are compatible with the sealants in accordance with procedures of ASTM C1087.
 - .5 Submit sealant manufacturer's verification that sealants are suitable for purposes intended.
- .5 Closeout Submittals: Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals and as follows:
 - .1 Submit data for cleaning of aluminum finishes and maintenance of operational hardware;
 - .2 Instruction for replacement of glass units (insulating and structural glass).

1.6 QUALITY ASSURANCE

- .1 Qualifications: The firm producing and executing the Work of this Section shall have experience in the fabrication and erection of systems of similar sizes, shapes and finishes to the units required for this project and shall have

ample facilities to produce, furnish and supply the units as required for installation without delay to the Work.

- .2 Delegated Design Professional: Retain a Professional Engineer, registered in the Province of the Work, to design fabrication and erection of the Work of this Section in accordance with applicable Building Code and Contract Documents requirements including, but not limited to, the following:
 - .1 Seal and signature to shop drawings and design submittals.
 - .2 Site review of installed components.

1.7 MOCK-UP

- .1 Construct mock-ups in accordance with Section 01 45 00 - Quality Control.
- .2 Provide 3000 x 3000 mm mock-up including intermediate mullion, corner mullion, sill muntin, column cover, vision glass light, and glass. Assemble to illustrate component assembly including glazing materials, weep drainage system, attachments, anchors, and perimeter sealant.
- .3 Mockup to include sloped glazed system and junction with vertical curtain wall and other vertical work mullions, muntins, structural member covers, vision glass light, and insulated glass. Assemble to illustrate component assembly including glazing materials, weep drainage system, attachments, anchors, and perimeter sealant.
- .4 Locate where directed.
- .5 Allow 24 hours for review of mock-up by Departmental Representative before proceeding with work.
- .6 When accepted, mock-up will demonstrate minimum standard for this work. Mock-up may not remain as part of finished work.

1.8 DELIVERY, STORAGE, AND HANDLING

- .1 Comply with AAMA CW-10 for care and handling of all aluminum Products through the entire manufacturing, finishing, fabrication, delivery and installation phases.
- .2 Protect metal and metal finishes to prevent damage during fabrication, storage, shipping, handling and installation.
- .3 Protect insulating glass units during shipment. Repair or replace damaged components or units as required to meet Contract requirements, and replace any gas leakage during shipping to specified concentrations.
- .4 Deliver, handle and store units by methods approved by manufacturer. Store units at site on wood platforms raised above grade or in enclosures protected from elements and corrosive materials. Stack units vertically in manner to prevent racking. Do not remove from crates or other protective covering until ready for installation.

1.9 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for recycling in accordance with Section 01 74 21 - Waste Management and Disposal.

1.10 SITE CONDITIONS

- .1 Site Measurements: Verify dimensions of other construction by site measurements before fabrication and indicate measurements on shop drawings where aluminum curtain wall systems are indicated to fit to other construction.
- .2 Established Dimensions: Establish dimensions and proceed with fabricating aluminum curtain wall without site measurements where site measurements cannot be made without delaying the Work, coordinated with other construction to ensure that actual dimensions correspond to established dimensions.
- .3 Ambient Conditions: Confirm installation requirements for ambient and surface temperatures of sealants with manufacturer and apply sealants when temperatures are greater than manufacturer's stated minimum from time of application until sealants have cured.

1.11 WARRANTY

- .1 Provide manufacturers written guarantee, signed and issued in the name of Owner, to replace the following items for defective material and workmanship for the time stated from date of Substantial Performance:
 - .1 Framing, panels and glazing: failure of performance requirements specified in Contract Documents; 10 years.
 - .2 Sealants, caulking: failure to maintain seal; 2 years.
 - .3 Aluminum brake shapes: oil-canning and delaminations; 2 years.
- .2 Provide Warranty for aluminum windows to include in maintenance manuals as specified in Section 01 78 00 – Operations and Maintenance Data Manuals.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturers: Subject to compliance with requirements specified in this Section and as established by the Basis-of-Design Materials, manufacturers offering products that may be incorporated into the Work include; but are not limited to, the following:
 - .1 A & D Prevost Inc.
 - .2 Alumicor Limited.
 - .3 CRL/US Aluminum
 - .4 Ferguson Glass Western Ltd. (Engineered Aluminum Products Inc.)
 - .5 Kawneer Canada Ltd.

2.2 PERFORMANCE/DESIGN CRITERIA

- .1 General Performance: Comply with performance requirements specified, as determined by testing of glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
 - .1 Glazed aluminum curtain walls shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening,

long-term creep, and deflection from uniformly distributed and concentrated live loads. Failure also includes the following:

- .1 Thermal stresses transferring to building structure.
 - .2 Glass breakage.
 - .3 Loosening or weakening of fasteners, attachments, and other components.
- .2 Retain a professional engineer registered in province of Work, experienced in structural design in glass and aluminum window units, connections to door units and connections to building, to ensure the adequacy of the structural aspects of the design, manufacture, and installation of complete assembly.
 - .3 Design and size components to withstand dead and live loads caused by pressure and suction of wind, acting normal to plane of system as calculated in accordance with Climatic Data for 1/30 year occurrence included in Building Code as measured in accordance with AAMA CW 11 and ASTM E330.
 - .4 Design and size components to withstand seismic loads and sway displacement as calculated in accordance with NBC.
 - .5 Limit mullion deflection to flexure limit of glass, with full recovery of glazing materials.
 - .6 Size glass units and glass dimensions to limits established in CAN/CGSB-12.20.
 - .7 Provide system to accommodate, without damage to components or deterioration of seals:
 - .1 Movement within system.
 - .2 Movement between system and perimeter framing components.
 - .3 Dynamic loading and release of loads.
 - .4 Deflection of structural support framing.
 - .5 Shortening of building concrete structural columns.
 - .6 Creep of concrete structural members.
 - .8 Limit air infiltration through assembly to $0.0003 \text{ m}^3/\text{s}/\text{m}^2$ of wall area, measured at a reference differential pressure across assembly of 75 Pa as measured in accordance with ASTM E283.
 - .9 Vapour seal with interior atmospheric pressure of 25 mm sp, 22 degrees C, 40% RH: No failure.
 - .10 Water leakage: none, when measured in accordance with AAMA 501
 - .11 System to provide for expansion and contraction within system components caused by a cycling temperature range of 95 degrees C over a 12 hour period without causing detrimental affect to system components.
 - .12 Drain water entering joints, condensation occurring in glazing channels, or migrating moisture occurring within system, to the exterior by a weep drainage network.
 - .13 Maintain continuous air barrier and vapour retarder throughout assembly, primarily in line with inside pane of glass and heel bead of glazing compound. Position thermal insulation on exterior surface of air barrier and vapour retarder.

- .14 Ensure no vibration harmonics, wind whistles, noises caused by thermal movement, thermal movement transmitted to other building elements, loosening, weakening, or fracturing of attachments or components of system occur.
- .15 Provide anchors sufficiently rigid to resist loads caused by equipment platform, without damage to wall system.
- .16 Tolerances:
 - .1 Design and install the curtain wall to accommodate tolerances of related work not included in this section. This requirement is in addition to building structure movements and deflections.
 - .2 Fabricate components to provide a plumb, square, level and true installation, and to accommodate allowable tolerances for work of other sections upon which work of this section depends.
 - .3 Erection tolerances for frame assemblies relate to the structural grid of the building, and apply to each individual assembly as follows:
 - .1 vertical position: +3 mm;
 - .2 horizontal position: +3 mm;
 - .3 deviation from plumb: 3 mm maximum each plane;
 - .4 racking of face: 6 mm maximum;
 - .5 racking in elevation: Nil;
 - .6 offset from true alignment between two identical members abutting end to end in line: 0.8 mm;
 - .7 tolerances shall not be accumulative;
 - .8 erection tolerances for operable elements: consistent with smooth operation and weatherproof performance.

2.3 MATERIALS

- .1 Extruded aluminum: Alloy and temper recommended by glazed aluminum curtain wall manufacturer for strength, corrosion resistance, application of required finish and complying with ASTM B221, Aluminum Association (AA) alloy 6063-T5 or 6063-T6.
- .2 Aluminum sheet (exposed): to ASTM B209, Aluminum Association (AA) alloy 1100, anodizing quality.
- .3 Aluminum sheet (unexposed): utility sheet to CSA HA-Series 6063 alloy, T5 temper.
- .4 Steel Reinforcement: to CSA G40.20/G40.21, 300W hot dipped galvanized after fabrication to ASTM A653/A653M, minimum coating of 600 g/m² shapes to suit mullion sections.
- .5 Aluminum welding: to CSA W59.2.
- .6 Stainless steel: to ASTM A480, Type 304 or 316; of one type throughout.
- .7 Anchors: 3-way adjustable hot-dip galvanized cast iron.
- .8 Pressure Plate: aluminum plate, fastened to the mullion with stainless steel screws.
- .9 Glass: Clear or Tinted, as indicated in window schedule, sealed glass units as specified under Section 08 80 50 – Glazing.

- .10 Fasteners: To ASTM A480, stainless steel, type 304 as recommended by curtain wall manufacturer selected to prevent galvanic action with the components fastened, of suitable size to sustain imposed loads.
- .11 Anti-Rotation Channels: Extruded aluminum anti-rotation channel designed to mechanically retain air seal membrane to the face of the tubular back section.
- .12 Grout fill for anchor pockets: non-shrink Masterflow 713 Plus, by BASF, or SikaGrout 212, by Sika Canada.
- .13 Primer for adhesives: as recommended by the adhesive manufacturer for the materials to be adhered.
- .14 Thermal separators (thermal break): of size to conform to the extruded aluminum members or other locations where required, neoprene, EPDM or polyvinyl chloride and having a minimum tensile strength of (14 MPa) (2000 psi) and Durometer A Hardness of 60, +/- 5.
- .15 Concealed Flashing: Manufacturer's standard corrosion resistant, non-staining, non-bleeding flashing compatible with adjacent materials.
- .16 Gaskets: Neoprene or EPDM with dimensional tolerances and durometer hardness and of suitable size and shape to meet the requirements of the specifications and their specific application, designed to remain flexible at low temperatures; heat resistant where required due to proximity of heating units.
 - .1 Gaskets shall be virgin material as manufactured by Tremco Ltd., Tremco Ltd. Gaskets shall conform to Tremco Information Bulletins:
 - .1 For EPDM - TDB-460-1;
 - .2 For Neoprene - TDB-270-1.
- .17 Isolation coating: alkali resistant bituminous paint.
- .18 Insulation for packing into voids and cavities: Lightweight resilient, inorganic fibrous glass having a nominal density of 11 kg/cu.m
- .19 Waterproofing sheet membrane at coping: sheet rubber, Sure Seal EPDM, by Lexcan Industrial Supply Limited or similar, minimum thickness 1.5 mm; adhesive, tapes and sealant for membrane: as manufactured by or recommended by the membrane manufacturer.
- .20 Flexible flashing, flexible air/vapour retarder:
 - .1 Compounded plasticized polyvinyl chloride reinforced with woven glass fibre mesh FR-40, by Lexsucu Canada Limited or similar, minimum thickness 40 mils.
 - .2 Adhesive, tapes, primers and sealant: as recommended by the flexible flashing manufacturer.
- .21 Glazing Tape: Refer to Section 08 80 50.
- .22 Sheet metal air/vapour barrier to be bonded to glazing frame and extended behind mounting frame. Seal to maintain continuity of seal. Install flexible flashing with continuous metal retaining strip to lap to interior wall assembly.
 - .1 Sheet metal for metal air/vapour barriers and air seals: ASTM A653 / A853M, minimum 1 mm sheet steel, galvanized, stretcher-levelled, minimum coating weight 380 g/m².

- .23 Sealants (including primer, joint filler): as specified in section 07 92 00 and as follows:
 - .1 Sealants used in structural joints shall have adequate strength to retain insulating units to the metal framing under design conditions.
 - .2 Sealants shall be from the same manufacturer for all work of this section.
 - .3 Materials used in the work shall be resistant to rodents, vermin, mildew, fungus and algae.
 - .4 Components in contact with opacifying coat at spandrel panels:
 - .1 Contact the opacifying coating manufacturer for confirmation of compatibility of sealant to the coating;
 - .2 Use neutral cure silicone components only in spandrel cavity. Do not use neoprene gaskets or setting blocks etc;
 - .3 Contact the opacifying coat manufacturer for a list of approved compatible list of sealants and materials, and tapes and gaskets;

2.4 FRAMING SYSTEM: STICK BUILT

- .1 Frame Type: To profiles and thicknesses required to meet performance criteria; but not less than 3 mm thickness, and as follows:
 - .1 Frame Dimensions: Nominal 65 mm wide x back as shown on Drawings, section having a 28 mm glazing throat.
 - .2 Cover Depth: Nominal 65 mm wide x 19 mm deep
 - .3 Acceptable Materials:
 - .1 A & D Prevost Inc., 3400 Series.
 - .2 Alumicor Limited, 2500 Series.
 - .3 CRL/US Aluminum, 3250 Series.
 - .4 Engineered Aluminum Products Inc., EAP 100.
 - .5 Kawneer Canada Inc., 1600 System 1.

2.5 GLAZING AND ACCESSORIES

- .1 Double Pane Insulating Glass Units: meet or exceed requirements of CAN/CGSB-12.8. Units shall be certified by the Insulated Glass Manufacturers Alliance (IGMA). Overall unit thickness shall be 25 mm using 6 mm glass thickness for individual panes. Use two stage seal method of manufacture, as follows:
 - .1 Primary Seal: polyisobutylene sealing compound between glass and metal spacer/separator, super spacer bar or TDSE Intercept.
 - .2 Secondary Seal: polyurethane, silicone or polysulphide base sealant, filling gap between the two lites of glass at the edge up to the spacer/separator and primary seal.
- .2 Spacer/separator to provide continuous vapour barrier between interior of sealed unit and secondary seal.
- .3 Clear Float Glass: to CAN/CGSB-12.3, glazing quality, for inner lite.
- .4 Safety Glass: to CAN/CGSB-12.1-M90.
 - .1 Class: B - Heat strengthened.

- .5 Provide low-E coating on No.3 surface of insulating glass units.
- .6 Glazing Gaskets for Sections: neoprene, thermoplastic rubber or EPDM, flexible at minimum design temperature, and as follows:
 - .1 Profiled with a minimum of three (3) fins to contact glazing and to mechanically key into window frame and sash glazing stops, at interior and exterior of glass units.
 - .2 Removable without special tools and without dismantling of window frames.
 - .3 Designed to maintain pressure contact against glass units through design temperature range.
 - .4 Coextruded material is not acceptable.
- .7 Glazing Gaskets for FRP Sections: Manufacturer's standard.
- .8 Other Glazing Accessories: setting blocks to CAN/CSA-A440.

2.6 FABRICATION: GENERAL

- .1 Do not start fabrication until samples, shop and erection drawings have been reviewed and have been approved.
- .2 Execute fitting and assembly in the shop, insofar as practical, with the various parts or assemblies ready for erection at the building site.
- .3 Where possible, take field measurements and levels required to verify or supplement those shown on the drawings for the proper layout and installation of the work. Coordinate dimensional tolerances in adjacent building elements and confirm prior to the commencement of the Work.
- .4 Weld aluminum, where required, with inert metal arc equipment. Welders to qualify according to CSA W47.2. Make exposed welds continuous and flush with adjacent surface. Do not mar surface finishes with welds in back of exposed aluminum. Do not deform the exposed metal and finish way by welding.
- .5 Weld steel, where required, to CSA W59. Welded joints to be of adequate strength and durability with jointing tight and flush. Welders to be fully approved by the Canadian Welding Bureau and to comply with CSA W47.1. Where it is necessary to weld components already galvanized, remove galvanizing for 50 mm around weld.
- .6 In locations where curtain wall framing extends up to top of roof parapets, the headrail and glazing cap shall be reinforced to withstand force from window cleaner's suspension chair ropes, which will extend over the top of the parapet and down the face of the building.
- .7 Make provisions in doors and frames to suit requirements of electrically operated hardware and security devices, as applicable, provided under other trades or sections. Blank, drill, reinforce and tap to receive hardware, security and electrical devices. Provide removable plates or knockouts for electrical contacts. Provide fish wires as required.
- .8 Visible manufacturer's identification labels not permitted

2.7 FABRICATION: FRAMING MEMBERS

- .1 Fabricate members to the profiles shown on the Drawings. Wall thickness of extrusions to be as required to meet the design requirements. Frames that are to receive insulating glass units shall have a continuous thermal break.
- .2 Accurately machine file and fit, and rigidly frame together joints, corners and mitres. Match components carefully to produce perfect continuity of line and design. Make exterior joints weathertight and interior joints airtight in accordance with specified allowances. Metal in contact to have hairline joints. Locations of exposed joints to be subject to the approval of the Departmental Representative.
- .3 Sill Trim: Provide continuous extruded "U" trim to inside of bottom rail at each level with provision for receiving steel base and convector covers, as detailed
- .4 Reinforce frames and assemblies by concealed means as necessary to meet the specified design requirements and as shown. Reinforcing to be hot-rolled mild steel and be securely anchored to horizontal and vertical members by approved positive mechanical means.
- .5 Seal hairline joints at junctions of frame members. Gun-inject sealant from inside ensuring a continuous seal of the joint. Ensure that bead in the glazing space does not impair seating of glazing materials. Remove excess sealant which is forced onto face of frame assembly.
- .6 Location of joints and pressure equalizing drain vents to be subject to Departmental Representative's acceptance.
- .7 Provide sheet continuous air/vapour barrier between framing and building structure. Overlap corner joints. Apply barriers and retain with continuous aluminum or galvanized steel plates or bars and non-corrosive mechanical fasteners. Where indicated, fill void between frame and other building components solid with foamed in place polyurethane foam insulation.
- .8 Develop drainage holes with moisture path to exterior.
- .9 Prepare components to receive anchor devices. Fabricate anchorage items.
- .10 Arrange fasteners, attachments, and jointing to ensure concealment from view.
- .11 Cope, notch and drill so as to provide minimum tolerance throughout system and to fit with hairline joints.
- .12 Conceal interconnecting members and fastenings in completed assembly. Provide pressure equalizing holes in members and condensation drains.
- .13 Provide for vertical expansions and construction joints as necessary and install air cut-offs in continuous vertical members to prevent stack effect of enclosed air columns.
- .14 Jointing and intersections of metals shall be accurately cut, fitted to a tolerance of 0.8 mm, in true planes with adequate concealed beads where required.
- .15 Fabricate expansions joints between mullion sections with formed extruded aluminum internal sleeve sections, secure to permit joint function and maintain true alignment of sections.
- .16 Fabricate sections to accommodate and interface with work of other sub-contractors by means of rabbets, interlocks, miscellaneous angles, trim and filler sections as required.

- .17 Fabricate mullions not less than one storey height with fully fashioned expansion joints adequate for expansion and contraction required. Avoid chimney effect inside mullions by stopping voids at each floor level with packing consisting of rigid insulation.
- .18 Brake form parapet caps and sills out of 3 mm thick aluminum sheet.
- .19 Reinforce mullions with structural steel sections where required with adequate anchorage to structure.
- .20 Provide internal reinforcement in horizontal window mullions to satisfy wind loads and to maintain rigidity.
- .21 Perform fitting and assembly of component parts in shop insofar as practicable. Work that cannot be permanently shop assembled shall be fitted, assembled, marked and disassembled to assure proper fitting in field. Identify shop assembled components on shop drawings for location and erection at site.
- .22 Isolate aluminum in contact with other metals, masonry, concrete, plaster or mortar to prevent corrosion.
- .23 Verify wall openings and adjoining air and vapour seal materials are ready to receive work of this section.
- .24 Beginning installation means acceptance of site conditions.
- .25 Provide airtight vapour seals in curtain wall framing.

2.8 FINISHES

- .1 Clear Anodized: Exposed aluminum surfaces shall be Aluminum Association (AA) Architectural Class I, AA-M12C22A41, clear anodized matching Kawneer #14.
- .2 Steel exposed to exterior conditions that is on cold-in-winter side of air/vapour barrier, but not exposed to view, shall be blast cleaned and hot dip galvanized in accordance with CAN/CSA G164, minimum coating mass 381 g/m². Thread dimensions to be such that nuts will thread over bolts without re-threading or chasing galvanized threads.
- .3 Galvanize after fabrication where possible. Follow standard precautions to avoid making the base metal brittle by over pickling, overheating or during galvanizing.
- .4 Concealed steel items: galvanized in accordance with CAN/CSA-G164M to 600 gm/m²
- .5 Apply one coat of bituminous paint to concealed aluminum and steel surfaces in contact with cementitious or dissimilar materials.

Part 3 Execution

3.1 INSPECTION

- .1 Inspect Work and conditions affecting the Work of this Section. Proceed only after deficiencies have been corrected.
- .2 Ensure that all flashings built-in or provided by others integrate with system to divert moisture to exterior.

- .3 Ensure that all anchor blocks or inserts required to receive system are correctly located and installed.
- .4 Ensure that all anchors and setting or installing components provided by this Section for installation are properly located and installed.
- .5 Ensure that building air and vapour retarding membranes can be sealed to window units to maintain system integrity. Coordinate with materials installation specified in Section 07 21 19 and Section 07 27 13.

3.2 PREPARATION

- .1 Coordinate dimensions, tolerances, and method of attachment with other work.
- .2 Supply anchorage devices and inserts to the appropriate sections where required for building in or casting-in-place and instruct as to proper location and position. Anchors shall have three-way adjustments.
- .3 Remove dust and other loose material from openings.
- .4 Verify that surfaces are ready to receive work and floor to floor dimensions are as indicated on shop drawings.

3.3 INSTALLATION: CURTAIN WALL

- .1 Install curtain wall systems to AAMA CWG-1-89, and manufacturer's written instructions, as required to meet or exceed specified performance criteria.
- .2 Use only concealed fasteners, type 304 stainless steel unless otherwise specified.
- .3 Erect all work plumb and true and in proper alignment and relationship to established lines and grades.
- .4 Devices for anchoring the frame assemblies shall have sufficient adjustment to permit correct and accurate alignment. After alignment, positively secure anchorage devices to prevent movement other than those designed for expansion and contraction. Take into consideration climatic conditions prevailing at time of installation.
- .5 Perform welding and drilling of concrete as required to install fixings. Repair, concrete chipped by drilling or fixing operations.
- .6 Group components with shop applied finishes so that those that relate most closely to one another, with regard to colour and appearance, shall be installed adjacent to each other.
- .7 Coordinate work of this section with, and provide connection for, compartmentalization of air spaces provided under other sections.
- .8 Provide thermal insulation and air/vapour barriers compatible and continuous with adjacent thermal and air/vapour barrier systems.
- .9 Apply continuous butyl sealing tape between sheets at lap and between steel and other materials. Screw sheets to each other and metal framing with type 304 stainless steel sheet metal screws, 150 mm o.c. maximum. Continuously seal perimeter of panels with tape and sealant. Place type 304 stainless steel washers over rubber washers under screw heads and cover with sealant to make fastenings air and vapour tight.

- .10 Seal joints of metal, apertures and protrusions of any kind with specified sealant to produce homogeneous air/vapour barrier seal. Joints shall be air, water and weathertight.
- .11 Apply a continuous bead of sealant to all joints and air/vapour barrier junctions with adjacent construction. Liberally butter screw fastenings with sealant.
- .12 Supply and install flexible, continuous gasket air/vapour barrier seals between work of this section and adjacent construction, and at deflection and expansion connections, where required. Prime substrates, apply gaskets to framing and to concrete and masonry with adhesive and retain with continuous aluminum or stainless steel plates or bars and non-corrosive mechanical fasteners. Ensure a continuous permanent seal at joints.
- .13 Provide air tight seals at penetrations in air/vapour barriers.
- .14 Apply insulation to the cold in winter side of air/vapour barriers. Ensure tight butt joints.
- .15 Adhere stick clips to metal air/vapour barriers at 300 mm o.c. both ways. As an alternative, gun weld apply pins to metal substrates in lieu of stick clips, provided clips do not easily break off and weld burn-through does not occur.
- .16 Support adhesive-applied clips in place until adhesive has set.
- .17 Isolate metal air/vapour barriers with thermal breaks and spacers.
- .18 Locate vapour barrier on the warm-in-winter side of the insulation.
- .19 Ensure a uniform, continuous thermal and vapour barrier effect. Where adjacent insulation and vapour barriers are to be provided under other sections, coordinate the work such that thermal and vapour barrier continuity is achieved. Ensure compatibility with adjacent thermal and air/vapour barrier systems. Ensure compatibility between tapes, sealants and air/vapour barriers.
- .20 Cut insulation as required and fit snugly to penetrations, obstructions, openings and corners. Butt insulation boards tightly. Cut out back of board insulation as required to accommodate substrate irregularities and build up over cut out areas on the other side as required to ensure thermal barrier uniformity unless otherwise approved.
- .21 Install insulation to thicknesses shown on the Drawings.
- .22 Press insulation boards firmly to barrier or substrate impaling them on clips without bending clips. Butt insulation boards tightly. Install retainers to clips.
- .23 Fill irregular shaped voids within assemblies with fibrous glass packing insulation to maintain continuity of thermal barrier.
- .24 Protect exterior finished surfaces by installing snap-on caps only when building is closed in, and when the possibility of damage due to construction has been minimized, to the approval of the Departmental Representative.
- .25 Secure snap-on caps with concealed stainless steel fasteners, minimum two per cap.
- .26 Install operable windows and related hardware, at locations indicated and ensure weathertight, rattle-free closure when units are in the closed and locked position. Perform drilling required to install stops and other hardware items fixed to adjacent construction.

- .27 Protect exterior finished surfaces by installing snap-on caps when the possibility of damage due to construction has been minimized.
- .28 Provide structural steel framing and supports required to support work of this Section unless indicated to be supplied under other Sections. Provide structural steel support or reinforcement for anchorage of railings.
- .29 Install window washing system pins in true alignment, to provide proper, smooth operation of window washing equipment. Provide support, anchorage, threaded sockets, and reinforcement required to receive pins.
- .30 Supply and install galvanized formed steel coping supports.
- .31 Supply and install sheet waterproofing membrane at copings and parapets as indicated. Lap, adhere, and seal joints in membrane in accordance with recommendations of the membrane manufacturer to provide a watertight, continuous membrane.
- .32 Gun-apply three continuous beads of sealant under extruded aluminum thresholds. Make bead diameter sufficient to ensure a full width seal. Remove excess sealant.

3.4 INSTALLATION GLAZING: FIELD

- .1 Install windows, vents, doors and skylights to AAMA/WDMA/CSA 101/I.S.2/A440.
- .2 Install glass and insulating glass units to GANA Glazing Manual recommendations, minimum, and as required to meet or exceed specified performance criteria.
- .3 Provide double-glass insulating vision lights and spandrel glass panels, as indicated on the drawings, throughout the curtain wall cladding.
- .4 Fabricate units accurately to size allowing 6 mm clearance between frame and glass edge. Butt joints shall be plumb and square, uniformly spaced. Ensure that glass rebates/glazing surfaces are clean and dry before placing glass and glazing gaskets and in place.
- .5 Apply structural glazing tape to faces of back-up mullions and setting blocks to top of horizontal rails, to evenly distribute weight.
- .6 Clean edges of glass units with recommended cleaner and lift them in place. Press into place to assure good contact between glazing gaskets/structural glazing tape and glass, and secure with temporary pressure plates/clamps. Align glass, as necessary; butt joints to be aligned and plumbed and centred on back-up mullion. Vertical joints shall be aligned top to bottom of curtain wall.
- .7 Run a continuous bead of structural sealant into void space between glass and backup mullion filling same completely. Tool/wipe flush with face of mullion. Install insulated back-pans behind spandrel panels. Fit flanges tight to frames and seal junctions.
- .8 Face seal butt joint behind horizontal pressure plates.
- .9 Remove temporary clamps/plates after silicone has set. Apply pressure plates and caps to horizontals to secure glass.

- .10 Excepting corner joints, open faces of vertical joints shall be covered with a snap-in-place, neoprene face seal gasket, colour matched to glass spandrels. Cut and fit ends tight to glazing caps. Corner joints shall be packed and sealed with structural silicone; tool surface and wipe off excess each side of joint.

3.5 SEALANT

.1 General:

- .1 Seal joints between frame assemblies and adjacent construction except where specified to be done under other sections, and within glazed assemblies where required to maintain weather tightness and integrity of air/vapour barrier. Seal junctions in sheet metal air/vapour barriers and between air/vapour barriers and adjacent construction.

.2 Preparation:

- .1 Ensure that joint conditions are suitable for the materials to be installed.
- .2 Ensure that surfaces to be sealed are sound, dry, free from dirt, water, frost, loose scale, corrosion, or other contaminants which may adversely affect the performance of the sealant materials. Remove protective oil coatings and other oil or grease films.
- .3 Perform cleaning to the extent required to achieve acceptable joint surfaces.
- .4 Protect cleaned and primed surfaces from further contamination by oil, dust, rain, condensation and other materials detrimental to sealant bonding strength. Re-clean and re-prime contaminated surfaces.
- .5 Install joint filler strips as backup for sealant to provide optimum joint profile, but not less than 6 mm depth of sealant bead. Provide bond breaker tapes where required.
- .6 Mask areas adjacent to the joints to prevent contamination of adjacent surfaces. Remove masking promptly after the joint has been completed.
- .7 If recommended by the manufacturer of the sealant materials, prime joints to prevent staining, or to assist the bond.
- .8 Apply primer with a brush which will permit all joint surfaces to be primed. Perform priming immediately before installation of sealant.

.3 Installation:

- .1 Obtain approval from the sealant manufacturer for the priming, cleaning and application techniques at commencement of the sealant installation.
- .2 Before sealant installation is commenced, test the sealant for adhesion to substrates.
- .3 Install materials in compliance with the recommendations of their manufacturers.
- .4 Do not exceed shelf life and pot life of materials, nor installation times, as stated by the manufacturer. Ensure sealant manufacturer's on-site quality control procedures are maintained.
- .5 Be familiar with the work life of the sealant to be used. Do not mix multiple component materials until required for use.
- .6 Mix sealants thoroughly with a mechanical mixer without mixing air into the materials. Continue mixing until the material is a uniform colour and free from streaks of unmixed material.

- .7 Before any sealing is commenced, test the materials for indications of staining or poor adhesion.
- .8 Sealants shall be of gun grade or knife grade consistency to suit the joint condition. Use gun nozzles of the proper sizes to suit the joints and the sealant material.
- .9 Install sealant with pressure operated guns.
- .10 Use sufficient pressure to fill all voids and joints full. Sealants shall bond to all sides of joint except where filler or bond breaker material is used. Where filler or bond break material is used, sealant shall bond to both sides of joints and shall not adhere to the filler or bond break material.
- .11 Ensure that the correct sealant depth is maintained. Superficial painting with a skin bead will not be accepted.
- .12 Sealant installations shall be a full bead free from air pockets and embedded impurities and having smooth surfaces, free from ridges, wrinkles and sags.
- .13 After joints have been completely filled, tool them neatly to a slightly concave surface.
- .14 If joints are masked, remove masking immediately after tooling and before sealants begin to cure.
- .15 Install exposed structural silicone sealants at glazing so that top surfaces of the beads are formed to drain water away from the glass.
- .16 Clean excess sealants from glass and framing surfaces immediately after installation.
- .17 Cover all fasteners penetrating the air/vapour barriers with sealant.
- .18 Immediately clean adjacent surfaces which have been soiled and leave work in a neat, clean condition. Remove excess materials and droppings using recommended cleaners and solvents.

3.6 FIELD QUALITY CONTROL

- .1 Inspection will monitor quality of installation and glazing.
- .2 Test to ASTM E1105, and AAMA 501.

3.7 MANUFACTURER'S FIELD SERVICES

- .1 Curtain wall product manufacturers to provide field surveillance of installation of their Products.
- .2 Monitor and report installation procedures, unacceptable conditions.

3.8 ADJUSTING

- .1 Replace defective materials and materials damaged due to faulty installation, careless handling or other causes resulting from work of this section.
- .2 Upon completion of the work and just prior to final review, or at a time as directed, inspect units for damage and correct same immediately.
- .3 Test and adjust hardware and replace or repair faulty items.
- .4 Adjust weather-stripping to leave each opening unit in its most weathertight position.
- .5 Test operable elements and ensure easy and smooth operation.

3.9 CLEANING

- .1 Remove protective material from pre-finished aluminum surfaces, interior and exterior.
- .2 Remove, as work progresses, corrosive and foreign materials that may set or become difficult to remove at time of final cleaning or that may damage members. Inspect minimum monthly to ensure cleanliness.
- .3 Wash exposed surfaces with a pre-approved cleaning solution approved by manufacturers of glass and aluminum. Take care to remove dirt from corners. Wipe surfaces clean.
- .4 Select, apply and maintain cleaning and protective methods to ensure finishes will not become uneven or impaired as a result of unequal exposure to light and weathering conditions.
- .5 Perform final cleaning after completion of entire installation when approved by the Departmental Representative. Remove dirt and stains where such does not respond to the washing or cleaning specified in Section 01 74 11, refer the condition to the Departmental Representative, with recommendations as to the remedial action required; but do not undertake any cleaning procedure of a more severe nature without the written approval.
- .6 Cleaning shall include the interior/exterior surfaces of materials installed under this section.
- .7 Remove excess sealant by moderate use of mineral spirits or other solvent acceptable to sealant manufacturer.
- .8 Final cleaning shall be performed under work of Section 01 74 11, Cleaning.
- .9 Upon completion of the work of this section, remove debris, equipment and excess material resulting from the work of this section from the site.
- .10 Provide the Owner with instructions for proper method and materials to be used in maintenance cleaning of finished surfaces.

3.10 PROTECTION

- .1 Protect finished Work from damage.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 05 50 00 – Metal Fabrications
- .2 Section 06 10 00 – Rough Carpentry
- .3 Section 07 21 19 – Foam-In-Place Insulation
- .4 Section 07 27 13 – Modified Bituminous Air and Vapour Barrier
- .5 Section 07 27 19 – Sheet Membrane Air and Vapour Barrier
- .6 Section 07 62 00 – Sheet Metal Flashing and Trim
- .7 Section 07 92 00 – Sealants
- .8 Section 08 71 00 – Door Hardware
- .9 Section 08 80 50 – Glazing
- .10 Section 09 91 00 – Painting

1.2 REFERENCES

- .1 American Architectural Manufacturers Association/Window and Door Manufacturers Association (AAMA/WDMA), American National Standards Institute/Window and Door Manufacturers Association (ANSI/WDMA)
 - .1 AAMA 1503-09, Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.
 - .2 AAMA 1503.1-88, Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.
 - .3 AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.
 - .4 AAMA 2605-11, Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
 - .5 AAMA 502 - Voluntary Specification for Field Testing of Windows and Sliding Doors.
 - .6 WDMA I.S.4-07, Water Repellant Preservative Treatment for Millwork.
- .2 ASTM International (ASTM)
 - .1 ASTM E283-04(2012) Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
 - .2 ASTM E330/E330M-14 Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
 - .3 ASTM E547-00(2009) Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Cyclic Static Air Pressure Difference.
 - .4 ASTM E1423-14 Standard Practice for Determining Steady State Thermal Transmittance of Fenestration Systems.

- .5 ASTM E1425-07 Standard Practice for Determining the Acoustical Performance of Windows, Doors, Skylight, and Glazed Wall Systems.
- .6 ASTM F588-14 Standard Test Methods for Measuring the Forced Entry Resistance of Window Assemblies, Excluding Glazing Impact.
- .3 Canadian Standards Association (CSA International)
 - .1 CSA A440-11, NAFS - North American Fenestration Standard/Specification for Windows, Doors, and Skylights, Includes Update No. 1 (2014).
 - .2 CSA A440.2-14/A440.3-14, Fenestration energy performance/User guide to CSA A440.2-14.
 - .3 CAN/CSA A440.4-07 (R2012) - Window, Door, and Skylight Installation.
 - .4 CSA Certification Program for Windows and Doors 2000.
- .4 Glass Association of North America (GANA)
 - .1 GANA Glazing Manual 50th Anniversary Edition.
- .5 Insulating Glass Manufacturer's Alliance (IGMA)
 - .1 TM-3000-90(04), Glazing Guidelines for Sealed Insulating Glass Units.
- .6 National Fenestration Rating Council (NFRC)
 - .1 NFRC 100-2014, Procedure for Determining Fenestration Product U-factors.
 - .2 NFRC 100A-2014, Procedure for Determining Fenestration Attachment Product U-factors.
 - .3 NFRC 200-2014, Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence.
 - .4 NFRC 200A-2014, Procedure for Determining Fenestration Attachment Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence
 - .5 NFRC 500-2014, Procedure for Determining Fenestration Product Condensation Resistance Values.
- .7 Passive House Certification (PH)
- .8 Window and Door Manufacturers Association (WDMA)
 - .1 ANSI/AAMA/NWDA 101/I.S.2 - Voluntary Specifications for Aluminum, Vinyl (PVC) and Wood Windows and Glass Doors.
 - .2 ANSI/AAMA/NWDA 101/I.S.2/NAFS-02 - Voluntary Performance Specification for Windows, Skylights and Glass Doors.
 - .3 WDMA I.S.4 - Industry Standard for Water-Repellent Preservative Non-Pressure Treatment for Millwork.

1.3 SUBMITTALS

- .1 Submit the following in accordance with Section 01 33 00 – Submittals:
 - .1 Submit manufacturer's product data including construction details, material descriptions, fabrication methods, dimensions of individual components and profiles, hardware, finishes, and operating instructions for each type of window and door indicated.

- .2 Submit shop drawings including plans, elevations, large-scale sections and details, hardware, attachments to other work, operational clearances, and the following:
 - .1 Sections details showing all window and door perimeter conditions.
 - .2 Sash frame details and corner connections, including reinforcement and stiffeners.
 - .3 Joinery and frame anchorage to wall structure details.
 - .4 Expansion provisions.
 - .5 Flashing and drainage details, sill flashing terminations, in isometric view, including coordination with wall cladding materials.
 - .6 Connection to air and vapour retarder membrane
 - .7 Weather stripping details showing air sealing within and around perimeter of framing and operable sash
 - .8 Glazing details.
 - .9 Required sizes and tolerances of openings.
- .3 Submit samples of windows and doors illustrating glazing system, quality of construction, and color and finish.
- .4 Submit product test reports indicating compliance with CSA A440 based on evaluation of comprehensive tests performed within the last four years by a qualified testing agency, for each type, grade, and size of window and door indicated for the project; test results based on use of down sized test units will not be accepted.
- .5 Provide a letter from window and door manufacturer identifying compliance with CSA A440 Design Criteria.
- .2 Submit maintenance data in accordance with Section 01 78 00 – Closeout Submittals.
 - .1 Provide manufacturer's printed recommendations for maintenance, including cleaning instructions.
- .3 PH Submittals: provide submittals as required for Passive House Certification Requirements.
- .4 Submit warranty.

1.4 QUALITY ASSURANCE

- .1 Testing: provide airtightness measurements in accordance with EN 13829 and ISO 9972 and as follows:

	EN 13829	ISO 9972
Leakage flow at 50 Pa (m ³ /h)	V ₅₀	q ₅₀
Air permeability at 50 Pa (m ³ /(h·m ²))	q ₅₀	q _{E50}
Air change rate at 50 Pa (h ⁻¹)	n ₅₀	n ₅₀

1.5 SINGLE SOURCE RESPONSIBILITY

- .1 Single-Source Responsibility: obtain windows and doors from a single manufacturer regularly engaged in the manufacturing and supply of the specified products, meeting or exceeding the material properties and performance characteristics of the materials and manufacturers named in this Section.

1.6 WARRANTY

- .1 Provide manufacturer's standard warranty indicating that the window and door unit will be free from material and workmanship defects from the date of Substantial Performance for the periods indicated below:
 - .1 Window Units: 20 years.
 - .2 Clad Finish: 20 years against peeling, checking, cracking caulk or color change.
 - .3 Glazing: Insulated Glass: 10 years against seal breakage.

Part 2 Products

2.1 MANUFACTURERS

- .1 Basis-of-Design:
 - .1 Windows: Zola No Compromise Aluminum Clad Wood Windows
 - .2 Doors: Zola Thermoplus Clad
- .2 Subject to compliance with requirements specified in this section and as established by the Basis-of-Design materials, manufacturers offering similar products may be incorporated into the Work.
- .3 Special Requirements: high performance units, manufactured to meet or exceed the requirements of this Section. Meet or exceed to performance characteristics and material properties of the Basis-of-Design product.

2.2 PERFORMANCE/DESIGN CRITERIA

- .1 Design pressure for windows and doors in accordance with the National Building Code.
- .2 Meet or exceed requirements of CSA A440, assuming an hourly design wind pressure of 540 Pa (11 psf), and the following performance requirements:
 - .1 Windows, Doors, Ventilators
 - .1 Performance class: CW.
 - .2 Performance grade: 30.
- .3 Windows: STC ratings as follows:
 - .1 Interior: STC 35
 - .2 Exterior STC 35
- .4 Provide airtightness testing as indicated above.

2.3 WINDOW MATERIALS

- .1 Frames: select woods, water-repellent, manufacturer's recommended preservative treated in accordance with WDMA I.S.-4 and as follows:
 - .1 Interior Exposed Surfaces: Selected by Departmental Representative from manufacture's standard. No visible fastener holes.
 - .2 Exterior Surfaces: Clad with aluminum.
 - .3 Sill Assembly: Mitered at ends where joined to curved head member
 - .4 Overall Frame Depth: as indicated on Drawings or as directed by Departmental Representative.
- .2 Surface Finish:
 - .1 Exterior Finish – Aluminum: Finish exposed surfaces of aluminum components in accordance with Aluminum Association Designation System for Aluminum Finishes.
 - .1 Anodized: Exposed aluminum surfaces shall be Aluminum Association (AA) Architectural Class II, AA-M12C22A31, clear anodized.
 - .2 Interior Finish – Wood: Colour as directed by Departmental Representative and in accordance with Section 09 91 00 – Painting.
- .3 Accessories and Trim:
 - .1 Provide manufacturer's accessories and trim, including stainless steel anchors, fasteners and fitments, as required for a complete installation.

2.4 DOOR MATERIALS

- .1 Frames: select woods, water-repellent, manufacturer's recommended preservative treated in accordance with WDMA I.S.-4 and as follows:
 - .1 Interior Exposed Surfaces: Pine. Confirm with Departmental Representative prior to ordering. No visible fastener holes.
 - .2 Exterior Surfaces: Clad with aluminum at head and jambs.
 - .3 Sill Assembly: sill profile as directed by Departmental Representative with anodized aluminum finish.
 - .4 Overall Frame Depth: as indicated on Drawings or as directed by Departmental Representative.
- .2 Door Panels: select woods, water-repellent, manufacturer's recommended preservative treated in accordance with WDMA I.S.-4 and as follows:
 - .1 Configuration: swing type as indicated on Drawings
 - .2 Interior Exposed Surfaces: Pine. Confirm with Departmental Representative prior to ordering.
 - .3 Exterior Surfaces: Clad with aluminum.
 - .4 Corners: Urethane-sealed and secured with metal fasteners and structural adhesive.

- .3 Surface Finish:
 - .1 Exterior Finish – Aluminum: Finish exposed surfaces of aluminum components in accordance with Aluminum Association Designation System for Aluminum Finishes.
 - .1 Anodized: Exposed aluminum surfaces shall be Aluminum Association (AA) Architectural Class II, AA-M12C22A31, clear anodized.
 - .2 Interior Finish – Wood: Colour as directed by Departmental Representative and in accordance with Section 09 91 00 – Painting.
- .4 Hardware: refer to Section 08 71 00 – Door Hardware and as directed by Departmental Representative.
- .5 Weatherstripping:
 - .1 Head, Jamb, Sill, and Astragal: Dual-extruded polypropylene TPE bulb.
 - .2 Bottom Rail of Door Panel: Secondary vinyl sweep to contact threshold sill weather strip.
- .6 Accessories and Trim:
 - .1 Provide manufacturer's accessories and trim, including stainless steel anchors, fasteners and fitments, as required for a complete installation.

2.5 GLAZING

- .1 Insulated Glazing Units: triple pane insulating glazing unit certified by IGMA. Glass thickness shall be in accordance with applicable Building Codes, but not less than 5.7 mm as indicated on Drawings. All insulated glass units shall be argon filled and have a low-E coating. Edge construction to consist of a primary seal of polyisobutylene; a tubular low conductivity stainless steel spacer-bar with sealed corners, filled with desiccant; and a secondary seal of neutral cure silicone.
- .2 Glazing Stop: Provide manufacturer standard glazing stops as required by sizing.
- .3 Glass: as indicated on Drawings and in accordance with Section 08 80 50 – Glazing.
- .4 Insulating Units: minimum performance requirements as follows:
 - .1 Triple Pane (typical):
 - .1 U-Value: 0.09.
 - .2 Solar Heat Gain: 0.53

2.6 ACCESSORIES

- .1 Flashing: refer to Section 07 62 00 – Sheet Metal Flashing and Trim.
- .2 Air and vapour barrier: in accordance with Section 07 27 13.
- .3 Foam-in-place insulation: to Section 07 21 19 – Foam-In-Place Insulation.
- .4 Sealants: to Section 07 92 00 – Sealants.

2.7 FABRICATION

- .1 Fabricate window and door units square and true with maximum tolerance of plus or minus 1.5 mm for units with a diagonal measurement of 1800 mm or less and 3 mm for units with a diagonal measurement over 1800 mm.
- .2 Continuously and uniformly compress length of gaskets during installation to compensate for linear shrinkage.
- .3 Glass shall be factory-installed into frames, to Section 08 80 50 – Glazing.

Part 3 Execution

3.1 COMPLIANCE

- .1 Install windows and doors to CAN/CSA A440.4, and as required to meet specified performance criteria.
- .2 Comply with manufacturer's printed installation instructions, standard details, and data sheets.

3.2 EXAMINATION

- .1 Verification of Conditions: Before installation, verify that openings are plumb and square and of proper dimension. Report frame defects or unsuitable conditions to the General Contractor before proceeding.
- .2 Acceptance: Beginning of installation means acceptance of existing conditions.

3.3 INSTALLATION

- .1 Erect and secure window and door units in prepared openings, plumb, and square, free from warp, twist, or superimposed loads.
- .2 Mount with exterior surface of frame flush with exterior sheathing.
- .3 Secure work accurately to structure and in a manner not restricting thermal movement of materials.
- .4 Transfer dead load to wall construction by anchors alone or in combination with plastic shims.
- .5 Place shims under sill frame at setting block locations, and as recommended by manufacturer.
- .6 Conceal anchors and fitments.
- .7 Maintain dimensional tolerances after installation and alignment with adjacent work.
- .8 Provide seal around interior perimeter of frame using foam joint sealant or foam backer rod, size as required to lightly compress between frame and rough opening, and sealant.
- .9 Provide seal at head and jamb of exterior perimeter of frame using foam joint sealant or foam backer rod, size as required to lightly compress between frame and rough opening, and sealant.

- .10 Install jamb extensions, casings, moulds and trim as indicated on Drawings, or as otherwise required for a complete installation.
- .11 Install doors and hardware in accordance with hardware templates and manufacturer's instructions, and to Section 08 71 10 - Door Hardware.
- .12 Install weatherstrip to provide positive contact.
- .13 Adjust doors for smooth and balanced door movement.

3.4 GLAZING

- .1 Install glass in accordance with Section 08 80 50 – Glazing.

3.5 FLASHING

- .1 Install flashing as required for proper management of wind driven rainwater: refer to Section 07 62 00 – Sheet Metal Flashing and Trim.

3.6 SEALANTS

- .1 Install sealants as required for weathertight and watertight installation, to Section 07 92 00 – Sealants.

3.7 CLEANING AND PROTECTION

- .1 Cover windows and doors during spray painting or other construction operations that might cause damage.
- .2 Clean interior and exterior surfaces as soon as adjacent contaminating activities are completed to recommendations of manufacturer.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 08 11 13 – Steel Doors and Frames.
- .2 Section 08 14 16 – Flush Wood Doors.
- .3 Division 26: Electrical wiring for magnetic strikes, electric releases and electric locks.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/Builders Hardware Manufacturers Association (BHMA)
- .2 Canadian Steel Door and Frame Manufacturers' Association (CSDFMA)
 - .1 CSDFMA Canadian Metric Guide for Steel Doors and Frames (Modular Construction): standard hardware location dimensions.
- .3 Builders Hardware Manufacturers Association (BHMA)
 - .1 Directory of Certified Products.
- .4 Door and Hardware Institute (DHI)
 - .1 Sequence and Format for the Hardware Schedule.
 - .2 ANSI/DHI A115.IG, Installation Guide for Doors and Hardware.

1.3 PRE-INSTALLATION MEETINGS

- .1 Pre-Installation Meetings: convene pre-installation meeting in accordance with Section 01 31 19 – Project Meetings to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's warranty requirements.

1.4 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures:
 - .1 Submit manufacturer's printed product literature, specifications and data sheets.
- .2 Submit samples in accordance with Section 01 33 00 – Submittals:
 - .1 Identify each sample by label indicating applicable specification paragraph number, brand name and number, finish and hardware package number.
 - .2 After approval samples will be returned for incorporation in the Work.
- .3 Hardware List:
 - .1 Submit contract hardware list in accordance with drawings.
 - .2 Indicate specified hardware, including make, model, material, function, size, finish and other pertinent information.

- .3 Coordinate Division 28 Security Contractor, Division 26 Electrical Contractor and Division 8 Door and Hardware Contractors to jointly prepare, submit, and obtain certified approval from the Departmental Representative shop drawings for work related to door access control systems prior to undertaking the on-site work. The joint submission will clarify and assign responsibility between these Divisions for labour and materials associated with the supply and installation of electronic and physical components for doors and access control. An individual drawing shall be submitted in AutoCadd format for each door within the project scope depicting both public and secure side of door and arrangement of access control and security components, conduit, and cabling.
- .4 Keying Schedule:
 - .1 Submit keying schedule prepared by or under the supervision of qualified Architectural Hardware Departmental Representative (AHC), detailing Owner's final keying instructions for locks, including schematic keying diagram and index each key set to unique door designations.
- .5 Manufacturer's Instructions:
 - .1 Submit manufacturer's installation instructions.
- .6 Closeout Submittals
 - .1 Provide operation and maintenance data for door closers, locksets, door holders electrified hardware and fire exit hardware for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 MAINTENANCE MATERIAL

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Supply two sets of wrenches for door closers, locksets, and fire exit hardware.

1.6 QUALITY ASSURANCE

- .1 Regulatory Requirements:
 - .1 Hardware for doors in fire separations and exit doors certified by a Canadian Certification Organization accredited by Standards Council of Canada.
- .2 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
- .3 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, Shipping, Handling and Unloading:
 - .1 Deliver, store, handle and protect materials in accordance with Section 01 61 00 - Common Product Requirements.

- .2 Package each item of hardware including fastenings, separately or in like groups of hardware, label each package as to item definition and location.
- .2 Storage and Protection:
 - .1 Store finishing hardware in locked, clean and dry area.

1.8 WASTE DISPOSAL AND MANAGEMENT

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Waste Management and Disposal.

1.9 WARRANTY

- .1 Provide written warranty, executed by manufacturer agreeing to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
- .2 Failures include, but are not limited to, the following:
 - .1 Structural failures including excessive deflection, cracking, or breakage.
 - .2 Faulty operation of operators and door hardware.
 - .3 Deterioration of metals, metal finishes, and other materials beyond normal weathering.
- .3 Warranty Period: From date of Substantial Performance, and as follows:

Hardware Type	Warranty Term
Locks, latches and cylinders	2 years
Closers	25 years
Hinges	1 year
Panics	3 years
Miscellaneous	1 year
Electrical Hardware:	5 years

Part 2 Products

2.1 HARDWARE ITEMS

- .1 Use one manufacturer's products only for similar items.

2.2 DOOR HARDWARE

- .1 Provide door hardware as indicated on Drawings.
- .2 Barrier Free Pneumatic Door Operator:
 - .1 Heavy duty pneumatically assisted door closer, capable of multi-door operation, complete with actuators, control boxes, pneumatic tubing and compressed air source.
 - .2 Self contained control box/compressor combination for independent operation of two door leaves.
 - .3 Control boxes: complete with electric strike relay.
 - .4 Mount operators on either push or pull sides of doors as required to place them inside rooms.
 - .5 Actuation of operators by motion detectors.

- .6 Electrical box and actuator: Hardwired low voltage actuator with stainless steel 114 mm round plate, engraved blue filled with handicap symbol. Box 51 mm wide x 102 mm high x 50 mm deep single gang electrical box, flush mounted in wall, locations indicated.
- .7 Provide switched line voltage to control box. Locate switch adjacent to box.
- .8 Provide low voltage wiring to each actuator and 6 mm diameter air tubing to each operator.
- .9 Mount control box in location as directed by Departmental Representative.

2.3 AUTOMATIC SWING DOOR OPERATORS

- .1 Coordinate the work of all trades, including glass and glazing, masonry, and electrical requirements covered in manufacturer's details and appropriate sections of the specifications.
- .2 The electrical contractor shall provide 117 volt, 60 cycle, single phase 15 ampere service for 1-2 operators, 30 ampere service for 3-4 operators, and as follows:
- .3 Coordinate with electrical contractor for provision of service to each operator from junction box for multiple operators.
- .4 Coordinate with electrical contractor shall provide electrical conduit and wiring from specified controls to operators as outlined on manufacturer's drawings.
- .5 Finish hardware supplier shall provide and install surface mounted electro-mechanical swing door operator, consisting of electro-mechanical swinging door operator and electronic control, aluminum header, connecting hardware, and power on/off switch and actuator switches, and as follows:
- .6 Automatic entrance equipment: comply with ANSI A156.10 or A156.19.
- .7 Aluminium header extrusions: minimum nominal 4 mm wall thickness with finish anodized AA-M12-C22-A31 clear.
- .8 Equipment must operate between -35°C and +55°C in all climate conditions.
- .9 Operator: Electro-mechanical system installed in a header to resist dust, dirt and corrosion; entire operator shall be removable from the header as a unit.
- .10 Bearings: Fully lubricated and sealed to minimize wear and friction.
- .11 Operator shall open the door with a 1/8 HP motor through reduction gears, door arm, and linkage assembly, and as follows:
- .12 Low energy operator, door opening time: not be less than 4 seconds.
- .13 The drive train shall have a positive, constant engagement. The operator shall stop the door in the open position by electrically reducing the motor voltage and stalling against a 90° stop.
- .14 Close the door by spring energy; controlled by employing the motor as a dynamic brake.
- .15 Door closing time shall not be less than 4.5 seconds.
- .16 Pre-load closing spring for positive closing action at a low material stress level for long spring life.

- .17 The operator shall function as a manual door closer in the direction of swing with or without electrical power.
- .18 The door forces and speeds generated during power opening, and manual opening in both directions of swing, and spring closing in both directions of swing shall conform to the requirements of ANSI A156.10 or A156.19.
- .19 Verify that no defects or errors are present in completed phases of the work that would result in poor application or installation, or cause latent defects of the automatic door equipment.
- .20 Installation and warranty adjustments shall be performed by authorized distributors factory trained technician.

2.4 FASTENINGS

- .1 Use only fasteners provided by manufacturer. Failure to comply may void warranties and applicable licensed labels.
- .2 Supply screws, bolts, expansion shields and other fastening devices required for satisfactory installation and operation of hardware.
- .3 Exposed fastening devices to match finish of hardware.
- .4 Where pull is scheduled on one side of door and push plate on other side, supply fastening devices, and install so pull can be secured through door from reverse side. Install push plate to cover fasteners.
- .5 Use fasteners compatible with material through which they pass.

2.5 KEYING

- .1 Doors, padlocks and cabinet locks to be keyed as directed. Prepare detailed keying schedule in conjunction with Departmental Representative.
- .2 Provide keys in duplicate for every lock in this Contract.
- .3 Provide three masterkeys for each MK or GMK group.
- .4 Stamp keying code numbers on keys and cylinders.
- .5 Key Control Cabinet:
 - .1 Multiple Drawer Cabinet: Cabinet with drawers equipped with key holding panels and key envelope storage, and progressive-type ball-bearing suspension slides. Include single cylinder lock to lock all drawers.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- .2 Furnish metal door and frame manufacturers with complete instructions and templates for preparation of their work to receive hardware.
- .3 Furnish manufacturers' instructions for proper installation of each hardware component.

3.2 INSTALLATION

- .1 Install hardware to standard hardware location dimensions in accordance with Canadian Metric Guide for Steel Doors and Frames (Modular Construction) prepared by Canadian Steel Door and Frame Manufacturers' Association.
- .2 Where door stop contacts door pulls, mount stop to strike bottom of pull.
- .3 Install key control cabinet.
- .4 Use only manufacturer's supplied fasteners. Failure to comply may void manufacturer's warranties and applicable licensed labels. Use of "quick" type fasteners, unless specifically supplied by manufacturer, is unacceptable.

3.3 INSTALLATION: AUTOMATIC SWING DOOR OPERATOR

- .1 Install components as indicated on drawings and as scheduled to manufacturer's recommendations.
- .2 Install door holders to limit doors to opening swing specified.
- .3 Install operators on interior side of exterior entrances.
- .4 Install rubber dampening devices to sound isolate operators from door frames.
- .5 Isolate aluminum surfaces from contact with cementitious materials, using thick coating of bituminous paint. Let paint dry before installation of aluminum component.
- .6 Conceal wiring between activating devices, electric locking system, and operators.

3.4 ADJUSTING

- .1 Adjust door hardware, operators, closures and controls for optimum, smooth operating condition, safety and for weather tight closure.
- .2 Lubricate hardware, operating equipment and other moving parts.
- .3 Adjust door hardware to provide tight fit at contact points with frames.

3.5 CLEANING

- .1 Perform cleaning after installation to remove construction and accumulated environmental dirt.
- .2 Clean hardware with damp rag and approved non-abrasive cleaner, and polish hardware in accordance with manufacture's instructions.
- .3 Remove protective material from hardware items where present.
- .4 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

3.6 DEMONSTRATION

- .1 Keying System Setup and Cabinet:
 - .1 Set up key control system with file key tags, duplicate key tags, numerical index, alphabetical index and key change index, label shields, control book and key receipt cards.

- .2 Place file keys and duplicate keys in key cabinet on their respective hooks.
 - .3 Lock key cabinet and turn over key to Owner.
- .2 Maintenance Staff Briefing:
 - .1 Brief maintenance staff regarding:
 - .1 Proper care, cleaning, and general maintenance of projects complete hardware.
 - .2 Description, use, handling, and storage of keys.
 - .3 Use, application and storage of wrenches for door closers, locksets, and fire exit hardware.
 - .3 Demonstrate operation, operating components, adjustment features, and lubrication requirements.

3.7 SCHEDULE

Hardware Group No. 1

For use on door #(s):

D1

Provide each SGL door(s) with the following:

4	EA	HINGE	5BB1HW 114X102MM	652	IVE
1	EA	DOOR PULL, 1" ROUND	8103EZHD 305MM I	630-316	IVE
1	EA	PUSH PLATE	8200 150X405MM	630	IVE
1	EA	OH STOP	100S ADJ	630	GLY
1	EA	SURF. AUTO OPERATOR	9542 MS	ANCLR	LCN
1	EA	ROCKER SWITCH	8310-806R	689	LCN
2	EA	ACTUATOR, WALL MOUNT	8310-856	630	LCN
2	EA	ESCUTCHEON	8310-874	689	LCN
1	EA	MOUNTING PLATE	9540-18	689	LCN
1	EA	KICK PLATE	8400 255MM X 40MM LDW B-CS	630	IVE

Hardware Group No. 2

For use on door #(s):

D2

Provide each SGL door(s) with the following:

3	EA	HINGE	5BB1HW 127X114MM NRP	630	IVE
1	EA	PANIC HARDWARE	98-L-03-1439	626	VON
1	EA	SURFACE CLOSER	4040XP SCUSH	689	LCN
1	EA	KICK PLATE	8400 255MM X 40MM LDW B-CS	630	IVE
1			WEATHERSTRIP BY DOOR SUPPLIER		
1	EA	DOOR SWEEP W/RAIN DRIP	8197AA	AA	ZER
1	EA	THRESHOLD	625A-V3	A	ZER

Hardware Group No. 3

For use on door #(s):

D3 D4

Provide each SGL door(s) with the following:

3	EA	HINGE	5BB1 114X102MM	652	IVE
1	EA	PRIVACY W/INDICATOR	L9456P 03B L583-363 L283-722	626	SCH
1	EA	KICK PLATE	8400 255MM X 40MM LDW B-CS	630	IVE
1	EA	WALL STOP	WS401/402CVX	626	IVE

Hardware Group No. 4

For use on door #(s):

D5

Provide each SGL door(s) with the following:

3	EA	HINGE	5BB1 114X102MM	652	IVE
1	EA	STOREROOM LOCK	L9080P 03B	626	SCH
1	EA	SURFACE CLOSER	1461 REG	689	LCN

1	EA	KICK PLATE	8400 255MM X 40MM LDW B-CS	630	IVE
1	EA	WALL STOP	WS401/402CVX	626	IVE

Hardware Group No. 5

For use on door #(s):

D11 D6

Provide each SGL door(s) with the following:

3	EA	HINGE	5BB1 114X102MM	652	IVE
1	EA	STOREROOM LOCK	L9080P 03B	626	SCH
1	EA	SURFACE CLOSER	1461 REG	689	LCN
1	EA	KICK PLATE	8400 255MM X 40MM LDW B-CS	630	IVE
1	EA	WALL STOP	WS401/402CVX	626	IVE
1	EA	GASKETING	188SBK PSA	BK	ZER

Hardware Group No. 6

For use on door #(s):

D7 D8

Provide each SL door(s) with the following:

1	EA	1 DR TRACK KIT COMPLETE	CCS-3-810 X SIZE OF OPENING		KNC
1	EA	SNAP ON FASCIA	CC-980		KNC
2	EA	END CAP	CC-982		KNC
1	EA	CYL OPERATED FLUSHBOLT	1877 (BTM LOCK)	626	ADA
2	EA	MORTISE CYLINDER	20-013 114	626	SCH
1	EA	DOOR PULL, 1" ROUND	PR 8103HD 255MM N	630	IVE

Hardware Group No. 7

For use on door #(s):

D9

Provide each PR door(s) with the following:

6	EA	HINGE	5BB1 114X102MM NRP	652	IVE
1	SET	CONST LATCHING BOLT	FB51P	630	IVE
1	EA	DUST PROOF STRIKE	DP2	626	IVE
1	EA	STOREROOM LOCK	L9080P 03B	626	SCH
1	EA	COORDINATOR	COR X FL	628	IVE
2	EA	SURFACE CLOSER	1461 REG	689	LCN
1	EA	GASKETING	188SBK PSA	BK	ZER
1	EA	MEETING STILE	44STST	STST	ZER

Hardware Group No. 8

For use on door #(s):

D10

Provide each PR door(s) with the following:

1	EA	CONT. HINGE	027XY	628	IVE
1	EA	CONT. HINGE	027XY EPT	628	IVE
1	EA	POWER TRANSFER	EPT10 CON	689	VON

1	EA	FIRE EXIT HARDWARE	9849-L-F-03 4'	626	VON
1	EA	ELEC FIRE EXIT HARDWARE	QEL-9849-L-F-03-CON 4'	626	VON
1	EA	OH STOP	100S	630	GLY
1	EA	OH STOP	100S ADJ	630	GLY
1	EA	SURFACE CLOSER	4021	689	LCN
1	EA	SURF. AUTO OPERATOR	9542 MS	ANCLR	LCN
1	EA	MOUNTING PLATE	4020-18G	689	LCN
1	EA	WEATHER RING	8310-800	BLK	LCN
1	EA	ROCKER SWITCH	8310-806R	689	LCN
2	EA	ACTUATOR, WALL MOUNT	8310-856	630	LCN
2	EA	ESCUTCHEON	8310-874	689	LCN
1	EA	MOUNTING PLATE	9540-18	689	LCN
1			WEATHERSTRIP BY DOOR SUPPLIER		
2	EA	DOOR SWEEP W/RAIN DRIP	8197AA	AA	ZER
1	EA	THRESHOLD	625A-V3	A	ZER
1	EA	WIRE HARNESS	CON-___ TO SUIT		SCH
1	EA	WIRE HARNESS	CON-6W		SCH
1	EA	POWER SUPPLY	PS902 900-4RL	LGR	SCE

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 08 11 13 – Steel Doors and Frames
- .2 Section 08 11 16 – Aluminum Doors and Frames
- .3 Section 08 14 16 – Flush Wood Doors
- .4 Section 08 44 13 – Glazed Aluminum Curtain Walls
- .5 Section 08 52 13 – Aluminum Clad Wood Windows and Doors
- .6 Section 08 87 53 – Glazing Films.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI).
 - .1 ANSI Z97.1-2015, Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM C542-05 (2011), Specification for Lock-Strip Gaskets.
 - .2 ASTM D790-15e2, Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - .3 ASTM D1003-13, Test Method for Haze and Luminous Transmittance of Plastics.
 - .4 ASTM D1929-16, Test Method for Determining Ignition Temperature of Plastics.
 - .5 ASTM D2240-15, Standard Test Method for Rubber Property - Durometer Hardness.
 - .6 ASTM E84-16, Test Method for Surface Burning Characteristics of Building Materials.
 - .7 ASTM E330/E330M-14, Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
 - .8 ASTM F1233-08(2013), Test Method for Security Glazing Materials and Systems.
 - .9 ASTM C1503-08(2013), Standard Specification for Silvered Flat Glass Mirror
- .3 Canadian General Standards Board (CGSB).
 - .1 CAN/CGSB-12.1-2017, Tempered or Laminated Safety Glass.
 - .2 CAN/CGSB-12.2-M91(R2017), Flat, Clear Sheet Glass.
 - .3 CAN/CGSB-12.3-M91(R2017), Flat, Clear Float Glass.
 - .4 CAN/CGSB-12.4-M91(R2017), Heat Absorbing Glass.
 - .5 CAN/CGSB-12.8-97 AMEND, Insulating Glass Units.
 - .6 CAN/CGSB-12.10-M76, Glass, Light and Heat Reflecting.
 - .7 CAN/CGSB 12.20-M89, Structural Design of Glass for Buildings
- .4 Canadian Standards Association (CSA International).

- .1 CAN/CSA A440.2-14/A440.3-14, Fenestration energy performance/User guide to CSA A440.2-09.
- .2 CSA Certification Program for Windows and Doors 2000.
- .5 Environmental Choice Program (ECP)
 - .1 CCD-045-95, Sealants and Caulking.
- .6 Glazing Association of North America (GANA)
 - .1 GANA Glazing Manual.
 - .2 GANA Glazing Reference.
- .7 Insulating Glass Manufacturers Alliance.
- .8 National Fire Protection Association (NFPA):
 - .1 NFPA 80, Standard for Fire Doors and Other Opening Protectives, 2016 Edition.
 - .2 NFPA 252, Fire Tests of Door Assemblies, 2017 Edition.
 - .3 NFPA 257, Fire Test for Window and Glass Block Assemblies, 2017 Edition.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Convene pre-installation meetings: one week prior to beginning work of this Section.
 - .1 Verify project requirements.
 - .2 Review installation conditions.
 - .3 Co-ordinate with other building subtrades.
 - .4 Review manufacturer's instructions and warranty requirements.

1.4 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittals.
 - .1 Submit manufacturer's printed product literature, specifications and data sheet.
 - .2 Submit two copies of WHMIS MSDS - Material Safety Data. Indicate VOC's:
 - .1 For glazing sealant materials during application and curing.
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittals.
 - .1 Submit shop drawings for window glazing and include the following:
 - .1 Submit glass thermal and wind load stress analysis documenting adequate glass thickness and/or heat treatment to meet stresses generated. Thermal stress analysis to consider effects of external shading, conduction at glass edge, heat build-up and contribution of Low-E coatings.
 - .2 Shop drawings shall be signed and sealed by a professional engineer qualified in the province of the Work, and who was responsible for their preparation.
- .3 Submit samples in accordance with Section 01 33 00 – Submittals.

- .1 Submit 300 mm x 300 mm size of each glazing type. Departmental Representative reserves the right to change colour of glass after review of submitted samples.
- .4 Information Submittals:
 - .1 Manufacturer's Instructions: Submit manufacturer's installation instructions.
 - .2 Submit proof of IGMAC certification for insulating glass units, including component codes.
- .5 Closeout Submittals:
 - .1 Provide maintenance data including cleaning instructions for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 QUALITY ASSURANCE

- .1 Manufacturer's technical recommendations:
 - .1 Perform glazing work in accordance with written recommendations from the glass manufacturer or glass fabricator.
 - .2 Certify glass compatibility with glazing materials (i.e. insulating glass sealants, structural sealants and silicones, gaskets, setting blocks, etc.)
 - .3 Designs to be analyzed for thermal stress and wind/snow loads.
 - .4 Provide shop inspection for glass.
- .2 Window fabricator shall be a member in good standing of the Fenestration Association of BC and adhere to the rules and regulations for workmanship, training and personnel as set forth by the association.
- .3 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
 - .1 Provide testing and analysis of glass under provisions of Section 01 45 00 - Quality Control.
 - .2 Provide shop inspection and testing for glass.
- .4 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .5 Glazing for Fire-Rated Door and Window Assemblies: Glass tested per NFPA 252 and NFPA 257, as applicable, for assemblies complying with NFPA 80 and listed and labelled per requirements of authorities having jurisdiction.

1.6 SITE CONDITIONS

- .1 Environmental Requirements:
 - .1 Install glazing when ambient temperature is 4 degrees C minimum. Maintain ventilated environment for 24 hours after application.
 - .2 Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.7 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Waste Management and Disposal.

1.8 WARRANTY

- .1 Provide manufacturers guarantee for the following types of glass listed, against defects in materials and workmanship for the period indicated, commencing from the date of Substantial Performance of Work.
 - .1 Sealed Glass Units: Replace units that exhibit failure of hermetic seal under normal use evidenced by the obstruction of vision by dust, moisture, or film on interior surface of glass: 10 Years.
 - .2 Provide warranty for glazing to include in maintenance manuals as specified in Section 01 78 00 – Operations and Maintenance Data Manuals.

Part 2 Products

2.1 MANUFACTURERS

- .1 Basis of Design products are named in this Section; additional manufacturers offering similar setting systems may be incorporated into the work provided they meet the performance requirements established by the named products.
- .2 Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - .1 Vision Glass:
 - .1 AGC Flat Glass North America (formerly AFG or AFGD)
 - .2 AHC Glass (formerly Visteon)
 - .3 Pilkington Glass of Canada
 - .4 Prelco Inc.
 - .5 Vitro Architectural Glass (formerly PPG Industries)
 - .6 Schott Glass AG
 - .7 Viracon Inc.

2.2 PERFORMANCE/DESIGN CRITERIA

- .1 Provide continuity of building enclosure vapour and air barrier using glass and glazing materials as follow:
 - .1 Utilize inner light of multiple light sealed units for continuity of air and vapour seal.
- .2 Size glass to withstand wind loads, dead loads and positive and negative live loads as measured in accordance with ANSI/ASTM E330 and in accordance with CAN/CGSB-12.20.
- .3 Limit center-of-glass deflection to the smallest of:
 - .1 Displacement associated with the structural capacity of the glazing unit.
 - .2 L-100, where L is the shortest side dimension of the unit measured in inches.

.3 Or 19 mm

2.3 MATERIALS

- .1 Safety glass: to CAN/CGSB-12.1, transparent, 6 mm minimum thickness.
 - .1 Type: 2-tempered.
 - .2 Class: B-float.
 - .3 Category: II – 540 J impact resistance.
- .2 Silvered mirror glass: to ASTM C1503, 5 mm thick.
 - .1 Type: 3A-Tempered
 - .2 Tint: Clear
 - .3 Edges:
- .3 Fire Rated Glass: Comprised of multiple layers of tempered glass ceramic, laminated with transparent intumescent materials, providing distortion free viewing through pane and as follows:
 - .1 Thickness: As required by manufacturer to meet structural requirements for performance and specified.
 - .2 Impact Safety Rating: Category I, 665 J/m in accordance with ANSI Z97.1.
 - .3 Temperature Rise Rating: Not required.
 - .4 Fire Rating: As indicated in door and frame schedule.
 - .5 Labelled: Permanent logo listing name of product, manufacturer, testing laboratory, fire rating period and safety requirements.
 - .6 Acceptable Manufacturers:
 - .1 InterEdge Technologies
 - .2 SAFTI Fire and Safety Rated Glass
 - .3 Saint-Gobain Glass Solutions
 - .4 Technical Glass Products
- .4 Low Emissivity (Low E) Glass: to CAN/CGSB-12.10, thickness as indicated and as follows:
 - .1 U-value Winter nighttime: 0.29
 - .2 U-value Summer Daytime: 0.27
 - .3 SHGC: 0.39
 - .4 Shading Coefficient: 0.45
 - .5 Visible Light transmittance: 70%
 - .6 Basis of Design:
 - .1 AGC, Energy Select 40
 - .2 Solarban 60, Vitro Architectural Glass (formerly PPG Industries)

2.4 MATERIALS: SEALED INSULATING GLASS

- .1 Drawings and Specifications for insulated glass units are intended to show design concept, configuration, components and arrangement; they are not intended to identify nor solve completely the problems from thermal stress. Insulating glass units shall withstand thermal stresses created by shadowing of exterior components or assembly and elevated interstitial space temperatures. Glass thermal stress analysis shall be provided by Contractor.
- .2 Double Pane Insulating Glass Units: meet or exceed requirements of CAN/CGSB-12.8. Units shall be certified by the Insulated Glass Manufacturers Alliance (IGMA). Overall unit thickness shall be 25 mm using 6 mm glass thickness for individual panes. Use two stage seal method of manufacture, as follows:
 - .1 Primary Seal: polyisobutylene sealing compound between glass and metal spacer/separator, super spacer bar or TDSE Intercept.
 - .2 Secondary Seal: polyurethane, silicone or polysulphide base sealant, filling gap between the two lites of glass at the edge up to the spacer/separator and primary seal.
- .3 Spacer/separator to provide continuous vapour barrier between interior of sealed unit and secondary seal.
- .4 Clear Safety Glass: to CAN/CGSB-12.1-M90 for inner and outer lite, as indicated on Drawings and as follows:
 - .1 Type: 2-tempered.
 - .2 Class: B-float.
- .5 Provide low-E coating on No.3 surface of insulating glass units.
- .6 Other Glazing Accessories: setting blocks to CAN/CSA-A440.

2.5 ACCESSORIES

- .1 Sealant: in accordance with Section 07 92 00 – Joint Sealants.
- .2 Setting blocks: Neoprene, EPDM, or Silicone, 80-90 Shore A durometer hardness to ASTM D2240, to suit glazing method, glass light weight and area.
- .3 Spacer shims: Neoprene or Silicone, 50-60 Shore A durometer hardness to ASTM D2240, 75 mm long x one half height of glazing stop x thickness to suit application. Self adhesive on one face.
- .4 Glazing tape:
 - .1 Preformed butyl compound with integral resilient tube spacing device, 10-15 Shore A durometer hardness to ASTM D2240; coiled on release paper; black colour.
 - .2 Closed cell polyvinyl chloride foam, coiled on release paper over adhesive on two sides, maximum water absorption by volume 2%, designed for compression of 25%, to effect an air and vapour seal.
- .5 Glazing compound for fire rated glazing materials:
 - .1 Glazing Tape: Closed cell polyvinyl chloride foam, coiled on release paper over adhesive on two sides, maximum water absorption by volume of 2%, designed for compression of 25% to effect an air and vapour seal.

- .2 Silicone Sealant: One-part neutral curing silicone, medium modulus sealant, Type S; Grade NS; Class 25 with additional movement capability of 50% in both extension and compression (total 100%); Use (Exposure) NT; Uses (Substrates) G, A, and O as applicable.
 - .1 Acceptable materials:
 - .1 Dow Corning Corp., Dow Corning 795
 - .2 General Electric Co., Silglaze-II 2800
 - .3 Tremco Inc., Spectrum 2
 - .3 Setting Blocks: Hardwood, glass width by 100 mm x 5 mm thick.
 - .4 Spacers: Neoprene or other resilient blocks of 40 to 50 Shore A durometer hardness, adhesive-backed on one face only, tested for compatibility with specified glazing compound.
 - .5 Cleaners, Primers, and Sealers: Type recommended by manufacturer of glass and gaskets.
- .6 Glazing splines: resilient polyvinyl chloride or silicone, extruded shape to suit glazing channel retaining slot, black colour.
- .7 Glazing clips: manufacturer's standard type.
- .8 Lock-strip gaskets: to ASTM C542.
- .9 Mirror attachment accessories:
 - .1 Stainless steel clips, with fastening concealed behind mirror.
 - .2 Mirror frames:

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: Comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.2 EXAMINATION

- .1 Verify that openings for glazing are correctly sized and within tolerance.
- .2 Verify that surfaces of glazing channels or recesses are clean, free of obstructions, and ready to receive glazing.

3.3 PREPARATION

- .1 Ensure all wood backing rebates and stops properly primed and finished, coordinate with Section 06 20 00 – Finish Carpentry and Section 06 40 00 – Architectural Woodwork.
- .2 Ensure all glazing rebates smooth and true, free of projections nails, screws, fastenings properly set to prevent contact with glass.
- .3 Ensure all stops, splines, glazing accessories provided by others accurately cut to length and proper size and type for specific glazing.
- .4 Clean contact surfaces with solvent and wipe dry.

- .5 Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- .6 Prime surfaces scheduled to receive sealant.

3.4 INSTALLATION: EXTERIOR - DRY METHOD (PREFORMED GLAZING)

- .1 Perform work in accordance with GANA Glazing Manual, IGMA, and GANA Laminated Glazing Reference Manual for glazing installation methods.
- .2 Cut glazing tape to length; install on glazing light. Seal corners by butting tape and sealing junctions with sealant.
- .3 Place setting blocks at 1/4 points, with edge block maximum 150 mm from corners.
- .4 Rest glazing on setting blocks and push against fixed stop with sufficient pressure to attain full contact.
- .5 Install removable stops without displacing glazing tape. Exert pressure for full continuous contact.
- .6 Trim protruding tape edge.

3.5 INSTALLATION: INTERIOR - DRY METHOD (TAPE AND TAPE)

- .1 Perform work in accordance with GANA Glazing Manual, IGMA, and GANA Laminated Glazing Reference Manual for glazing installation methods.
- .2 Cut glazing tape to length and set against permanent stops, projecting 1.6 mm above sight line.
- .3 Place setting blocks at 1/4 points, with edge block maximum 150 mm from corners.
- .4 Rest glazing on setting blocks and push against tape for full contact at perimeter of light or unit.
- .5 Place glazing tape on free perimeter of glazing in same manner described.
- .6 Install removable stop without displacement of tape. Exert pressure on tape for full continuous contact.
- .7 Knife trim protruding tape.

3.6 FIRE RATED GLASS

- .1 Comply with GANA standards and instructions of manufacturers of glass, glazing sealants, and glazing compounds.
- .2 Protect glass from edge damage during handling and installation. Inspect glass during installation and discard pieces with edge damage that could affect glass performance.
- .3 Place hardwood setting blocks located at quarter points of glass with edge block no more than 150 mm from corners.
- .4 Glaze vertically into labelled fire rated metal frames or partition walls with same fire rating as glass and push against tape for full contact at perimeter of pane or unit.
- .5 Place glazing tape on free perimeter of glazing in same manner described above.

- .6 Do not remove protective edge tape.
- .7 Install removable stop and secure without displacement of tape.
- .8 Do not pressure glaze.
- .9 Knife trim protruding tape.
- .10 Provide minimum 5 mm edge clearance.
- .11 Install vision panels in fire rated doors to requirements of NFPA 80.
- .12 Install so that appropriate fire rating labels and markings remain permanently visible.

3.7 INSTALLATION: MIRRORS

- .1 Set mirrors with adhesive, applied in accordance with adhesive manufacturer's instructions.
- .2 Set mirrors with clips. Anchor rigidly to wall construction.
- .3 Secure mirrors with a minimum of 4 clips per piece. Provide pads to prevent direct metal-to-glass contact of clips or screws.
- .4 **Set in frame.**
- .5 Align mirrors (in multiple application) to a parallel and true plane surface to produce a true reflection across all sections.
- .6 Install plumb and level.

3.8 CLEANING

- .1 Perform cleaning after installation to remove construction and accumulated environmental dirt.
- .2 Remove traces of primer, caulking.
- .3 Remove glazing materials from finish surfaces.
- .4 Remove labels after work is complete.
- .5 Clean glass and mirrors using approved non-abrasive cleaner in accordance with manufacture's instructions.
- .6 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

3.9 PROTECTION OF FINISHED WORK

- .1 After installation, mark light with an "X" by using removable plastic tape or paste.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 06 10 00 – Rough Carpentry
- .2 Section 07 21 16 – Fibrous Insulation
- .3 Section 07 27 19 – Sheet Membrane Air and Vapour Barrier
- .4 Section 07 84 00 – Firestopping
- .5 Section 07 92 00 – Sealants
- .6 Section 09 22 00 – Non-Structural Metal Framing
- .7 Section 09 91 00 – Painting

1.2 REFERENCES

- .1 Aluminum Association (AA)
 - .1 AA DAF-45-2003(R2009), Designation System for Aluminum Finishes.
- .2 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM C475/C475M-15, Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
 - .2 ASTM C514-04(2014), Specification for Nails for the Application of Gypsum Board.
 - .3 ASTM C557-03(2017), Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing.
 - .4 ASTM C840-17, Specification for Application and Finishing of Gypsum Board.
 - .5 ASTM C954-15, Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.
 - .6 ASTM C1002-16, Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
 - .7 ASTM C1047-14a, Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
 - .8 ASTM C1177/C1177M-13, Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
 - .9 ASTM C1178/C1178M-13, Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel.
 - .10 ASTM C1278/C1278M-07a(2015), Standard Specification for Fiber-Reinforced Gypsum Panel.
 - .11 ASTM C1280-13a, Specification for Application of Exterior Gypsum Panel Products for Use as Sheathing.
 - .12 ASTM C1396/C1396M-14a, Standard Specification for Gypsum Board.
 - .13 ASTM C1658/C1658M-13, Standard Specification for Glass Mat Gypsum Panels
- .3 Association of the Wall and Ceilings Industries International (AWCI)

- .4 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-51.34-M86., AMEND., Vapour Barrier, Polyethylene Sheet for Use in Building Construction.
- .5 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-10, Surface Burning Characteristics of Building Materials and Assemblies.

1.3 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittals:
 - .1 Submit manufacturer's printed product literature, specifications and data sheet for each product specified.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver materials in original packages, containers or bundles bearing manufacturers brand name and identification.
- .2 Store materials inside, level, under cover. Keep dry. Protect from weather, other elements and damage from construction operations and other causes.
- .3 Handle gypsum boards to prevent damage to edges, ends or surfaces. Protect metal accessories and trim from being bent or damaged.

1.5 SITE ENVIRONMENTAL REQUIREMENTS

- .1 Maintain temperature minimum 10 degrees C, maximum 21 degrees C for 48 hours prior to and during application of gypsum boards and joint treatment, and for at least 48 hours after completion of joint treatment.
- .2 Apply board and joint treatment to dry, frost free surfaces.
- .3 Ventilation: Ventilate building spaces as required to remove excess moisture that would prevent drying of joint treatment material immediately after its application.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Waste Management and Disposal.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturers:
 - .1 CertainTeed Gypsum Canada Inc.
 - .2 CGC Inc.
 - .3 Georgia-Pacific Canada, Inc.

2.2 GYPSUM MATERIALS

- .1 Standard board: to ASTM C1396/C1396M and as follows:
 - .1 Type: regular and fire resistant.

- .2 Size: 1220 mm x maximum practical length.
- .3 Thickness: as indicated on Drawings.
- .4 Ends: square cut.
- .5 Edges: tapered
- .6 Acceptable materials:
 - .1 Wallboard (Type X), CertainTeed.
 - .2 Sheetrock (Firecode), CGC Inc.
 - .3 Toughrock Gypsum Wallboard (Fireguard), Georgia-Pacific Canada, Inc.
- .2 Lightweight Fire Resistant board: to ASTM C1396/C1396M and as follows:
 - .1 Type: fire resistant.
 - .2 Size: 1220 mm x maximum practical length.
 - .3 Thickness: as indicated on Drawings.
 - .4 Ends: square cut.
 - .5 Edges: tapered
 - .6 Acceptable materials:
 - .1 Ultralight Panels Firecode X, CGC Sheetrock.
- .3 Sag Resistant Gypsum Board: to ASTM C1396/C1396M and as follows:
 - .1 Type: regular and fire resistant.
 - .2 Thickness: as indicated on Drawings.
 - .3 Acceptable materials:
 - .1 CD Ceiling Board, Georgia-Pacific Canada, Inc.
 - .2 Interior Ceiling Board, CertainTeed.
 - .3 Sheetrock Interior Ceiling Board, CGC Inc.

2.3 FRAMING MATERIALS

- .1 Studs and Tracks: as indicated in Section 09 22 00.
- .2 Metal furring runners, hangers, tie wires, inserts, anchors.
- .3 Drywall furring channels: 0.75 mm core thickness galvanized steel channels for screw attachment of gypsum board.
- .4 Resilient drywall furring: 0.5 mm base steel thickness galvanized steel for resilient attachment of gypsum board.

2.4 INSULATION MATERIALS

- .1 Mineral Fiber Insulation For Fire and Smoke Rated Assemblies: Un-faced preformed GreenGuard™ or formaldehyde free binder fibrous insulation meeting the requirements of ULC S702; having maximum flame spread and smoke developed of 20/20 in accordance with CAN/ULC S102 and being non-combustible in accordance with CAN/ULC S114 and as follows:
 - .1 Type: 1.
 - .2 Width: to friction fit in stud spaces.
 - .3 Thickness: to fill a minimum of 90% of the cavity thickness.
 - .4 Acceptable materials:

- .1 Johns Manville, MinWool Sound Attenuation Fire Batts
 - .2 Owens-Corning Canada LP, EcoTouch QuietZone PINK FiberGlas Acoustic Insulation
 - .3 Rockwool Inc., Roxul AFB Acoustical Fire Batt.
- .2 Mineral Fiber Acoustical Insulation For Non-rated Assemblies: Un-faced, preformed GreenGuard™ or formaldehyde free binder fibrous insulation meeting the requirements of ASTM C423, ASTM E90, ASTM E413 and ULC S702 and as follows:
 - .1 Type: 1.
 - .2 Width: to friction fit in stud spaces.
 - .3 Thickness: to fill a minimum of 90% of the cavity thickness.
 - .4 Acceptable materials:
 - .1 CertainTeed, NoiseReducer, Sound Control Fibre Glass Batts.
 - .2 Johns Manville, Sound Shield Glass Fibre Batts.
 - .3 Owen-Corning Canada LP., EcoTouch Quietzone PINK FiberGlas Acoustic Insulation.

2.5 CEILING/WALL ACCESS DOORS

- .1 Architectural, flush mounting access panels for gypsum board installation, thickness and fire rating to match wall assembly, manufacturer's standard sizes selected to suit access requirements, complete with extruded aluminum frame, concealed hinge and a removable door panel, air tight gasket and screwdriver slot latch mechanism. Confirm proposed location and number of access doors with Departmental Representative prior to installation.
 - .1 Basis-of-Design: Bauco Products Incorporated, Bauco Plus.
 - .2 Acceptable Manufacturers:
 - .1 Access Panel Solutions
 - .2 Acudor Products, Inc.
 - .3 Chicago Metallic/Rockfon Corporation
 - .4 Nystrom Building Products Co.

2.6 ACCESSORIES

- .1 Nails: to ASTM C514.
- .2 Steel drill screws: to ASTM C1002.
- .3 Stud adhesive: to CAN/CGSB-71.25.
- .4 Laminating compound: as recommended by manufacturer, asbestos-free.
- .5 Casing beads, corner beads, control joints and edge trim: to ASTM C1047, ABS, PVC, or Zinc, 0.5 mm base thickness, perforated flanges, one piece length per location.
- .6 Shadow mould: 35 mm high, snap-on trim, of 0.6 mm base steel thickness galvanized sheet pre-finished in satin enamel, white colour.
- .7 Strippable Edge Trim: Extruded PVC with pre-masked L-shaped tape on trim with tear away protective serrated strip for removal after compound and paint is

applied, for use at areas where gypsum butts aluminum frames and where gypsum butts concrete or concrete block.

- .8 Sealants: in accordance with Section 07 92 00 - Sealants.
- .9 Acoustic sealant: in accordance with Section 07 92 00 – Sealants.
- .10 Polyethylene: in accordance with Section 07 27 13 – Sheet Membrane Air and Vapour Barrier.
- .11 Insulating strip: rubberized, moisture resistant, 3 mm thick cork or closed cell neoprene strip, 12 mm wide, with self sticking permanent adhesive on one face, lengths as required.
- .12 Joint Treatment Materials: Provide joint compound and accessory materials in accordance with ASTM C475 and as follows:
 - .1 Joint Tape:
 - .1 Interior Gypsum Board: Paper.
 - .2 Joint Compound for Interior Gypsum Board: Vinyl based, non-asbestos, low dusting type compatible with other compounds applied on previous or for successive coats, and as follows:
 - .1 Pre-filling: Setting type taping compound.
 - .2 Embedding and First Coat: Drying type compound.
 - .3 Fill Coat: Drying type compound.
 - .4 Finish Coat: Drying type, sandable topping compound.
 - .5 Acceptable Materials:
 - .1 CertainTeed Dust Away
 - .2 CGC Dust Control

2.7 FINISHES

- .1 Paint: in accordance with Section 09 91 00 – Painting.

Part 3 Execution

3.1 ERECTION

- .1 Do application and finishing of gypsum board in accordance with ASTM C840 except where specified otherwise.
- .2 Do application of gypsum sheathing in accordance with ASTM C1280.
- .3 Erect hangers and runner channels for suspended gypsum board ceilings in accordance with ASTM C840 except where specified otherwise.
- .4 Support light fixtures by providing additional ceiling suspension hangers within 150 mm of each corner and at maximum 600 mm around perimeter of fixture.
- .5 Install work level to tolerance of 1:1200.
- .6 Frame with furring channels, perimeter of openings for access panels, light fixtures, diffusers, grilles.
- .7 Install 19 x 64 mm furring channels parallel to, and at exact locations of steel stud partition header track.

- .8 Furr gypsum board faced vertical bulkheads within and at termination of ceilings.
- .9 Furr above suspended ceilings for gypsum board fire and sound stops and to form plenum areas as indicated.
- .10 Install wall furring for gypsum board wall finishes in accordance with ASTM C840, except where specified otherwise.
- .11 Furr openings and around built-in equipment, cabinets, access panels, on four sides. Extend furring into reveals. Check clearances with equipment suppliers.
- .12 Furr duct shafts, beams, columns, pipes and exposed services where indicated.
- .13 Erect drywall resilient furring transversely across studs and joists spaced maximum 600 mm on centre and not more than 150 mm from ceiling/wall juncture. Secure to each support with 25 mm drywall screw.
- .14 Install 150 mm continuous strip of 12.7 mm gypsum board along base of partitions where resilient furring installed.

3.2 APPLICATION

- .1 Do not apply gypsum board until bucks, anchors, blocking, sound attenuation, electrical and mechanical work are approved.
- .2 Apply single or double layer gypsum board to wood furring or framing using screw fasteners for first layer, screw fasteners for second layer. Maximum spacing of screws 300 mm on centre.
 - .1 Single-Layer Application:
 - .1 Apply gypsum board on ceilings prior to application of walls in accordance with ASTM C840.
 - .2 Apply gypsum board vertically or horizontally, providing sheet lengths that will minimize end joints.
 - .2 Double-Layer Application:
 - .1 Install gypsum board for base layer and exposed gypsum board for face layer.
 - .2 Apply base layer to ceilings prior to base layer application on walls; apply face layers in same sequence. Offset joints between layers at least 250 mm.
 - .3 Apply base layers at right angles to supports unless otherwise indicated.
 - .4 Apply base layer on walls and face layers vertically with joints of base layer over supports and face layer joints offset at least 250 mm with base layer joints.
- .3 Apply 12 mm diameter bead of acoustic sealant continuously around periphery of each face of partitioning to seal gypsum board/structure junction where partitions abut fixed building components. Seal full perimeter of cut-outs around electrical boxes, ducts, in partitions where perimeter sealed with acoustic sealant.
- .4 Apply board using stud adhesive on furring or framing
- .5 Install ceiling boards in direction that will minimize number of end-butt joints. Stagger end joints at least 250 mm.

- .6 Install gypsum board on walls vertically to avoid end-butt joints. At stairwells and similar high walls, install boards horizontally with end joints staggered over studs, except where local codes or fire-rated assemblies require vertical application.
- .7 Install gypsum board with face side out.
- .8 Do not install damaged or damp boards.
- .9 Locate edge or end joints over supports. Stagger vertical joints over different studs on opposite sides of wall.

3.3 INSTALLATION

- .1 Erect accessories straight, plumb or level, rigid and at proper plane. Use full length pieces where practical. Make joints tight, accurately aligned and rigidly secured. Mitre and fit corners accurately, free from rough edges. Secure at 150 mm on centre or using contact adhesive for full length.
- .2 Install casing beads around perimeter of suspended ceilings.
- .3 Install casing beads where gypsum board butts against surfaces having no trim concealing junction and where indicated. Seal joints with sealant.
- .4 Install insulating strips continuously at edges of gypsum board and casing beads abutting metal window and exterior door frames, to provide thermal break.
- .5 Install shadow mould at gypsum board/ceiling juncture as indicated. Minimize joints; use corner pieces and splicers.
- .6 Construct control joints of preformed units or two back-to-back casing beads set in gypsum board facing and supported independently on both sides of joint.
- .7 Provide continuous polyethylene dust barrier behind and across control joints.
- .8 Locate control joints where indicated and at changes in substrate construction at approximate 10 m spacing on long corridor runs at approximate 15 m spacing on ceilings.
- .9 Install control joints straight and true.
- .10 Construct expansion joints at building expansion and construction joints. Provide continuous dust barrier.
- .11 Install expansion joint straight and true.
- .12 Splice corners and intersections together and secure to each member with 3 screws.
- .13 Install access doors to electrical and mechanical fixtures specified in respective sections.
 - .1 Rigidly secure frames to furring or framing systems.
- .14 Finish face panel joints and internal angles with joint system consisting of joint compound, joint tape and taping compound installed according to manufacturer's directions and feathered out onto panel faces.
- .15 Gypsum Board Finish: finish gypsum board walls and ceilings to following levels in accordance with Association of the Wall and Ceiling Industries (AWCI) International Recommended Specification on Levels of Gypsum Board Finish:
 - .1 Levels of finish:

- .1 Level 0: No taping, finishing or accessories required for areas of temporary construction.
 - .2 Level 1: Embed tape for joints and interior angles in joint compound. Surfaces to be free of excess joint compound; tool marks and ridges are acceptable and for plenum areas above ceilings, in attics or in concealed spaces.
 - .3 Level 2: Embed tape for joints and interior angles in joint compound and apply one separate coat of joint compound over joints, angles, fastener heads and accessories; surfaces free of excess joint compound; tool marks and ridges are acceptable and when gypsum is used as a substrate for tile.
 - .4 Level 3: Embed tape for joints and interior angles in joint compound and apply two separate coats of joint compound over joints, angles, fastener heads and accessories; surfaces smooth and free of tool marks and ridges and where areas are to receive a heavy coating of textured material.
 - .5 Level 4: Embed tape for joints and interior angles in joint compound and apply three separate coats of joint compound over joints, angles, fastener heads and accessories; surfaces smooth and free of tool marks and ridges and where light textures or wall coverings are to be applied.
- .16 Finish corner beads, control joints and trim as required with two coats of joint compound and one coat of taping compound, feathered out onto panel faces.
 - .17 Fill screw head depressions with joint and taping compounds to bring flush with adjacent surface of gypsum board so as to be invisible after surface finish is completed.
 - .18 Sand lightly to remove burred edges and other imperfections. Avoid sanding adjacent surface of board.
 - .19 Completed installation to be smooth, level or plumb, free from waves and other defects and ready for surface finish.
 - .20 Mix joint compound slightly thinner than for joint taping.
 - .21 Apply thin coat to entire surface using trowel or drywall broadknife to fill surface texture differences, variations or tool marks.
 - .22 Remove ridges by light sanding or wiping with damp cloth.
 - .23 Provide protection that ensures gypsum drywall work will remain without damage or deterioration at time of substantial completion.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 06 10 00 – Rough Carpentry
- .2 Section 07 92 00 – Sealants
- .3 Section 09 67 23 – Resinous Flooring

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM F1861-08(2012)e1, Standard Specification for Resilient Wall Base.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .3 South Coast Air Quality Management District (SCAQMD), California State
 - .1 SCAQMD Rule 1113-13, Architectural Coatings.
 - .2 SCAQMD Rule 1168-05, Adhesives and Sealants Applications.
- .4 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC S102.2-10, Method of Test for Surface Burning Characteristics of Flooring, Floor Covering and Miscellaneous Materials and Assemblies.

1.3 QUALITY ASSURANCE

- .1 Regulatory Requirements: Provide products that meet requirements of ULC S102.2 as applicable for required flame spread ratings; labelled and listed by Underwriters Laboratories of Canada (ULC), or another testing and inspecting agency acceptable to authorities having jurisdiction.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials in good conditions to the jobsite in the manufacturer's original unopened containers that bear the name and brand of the manufacturer, project identification, and shipping and handling instructions.
- .3 Store materials in a clean, dry, enclosed space off the ground, and protect from the weather and from extremes of heat and cold. Protect adhesive from freezing. Store flooring, adhesives and accessories in the spaces where they will be installed for at least 48 hours before beginning installation.

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Waste Management and Disposal.

1.6 AMBIENT CONDITIONS

- .1 Maintain air temperature and structural base temperature at flooring installation area above 20 degrees for 48 hours before, during and 48 hours after installation.

1.7 WARRANTY

- .1 Provide Manufacturers Warranty for product to be free from manufacturers defects for a period of five (5) years from date of substantial performance.

Part 2 Products

2.1 MATERIALS

- .1 Basis-of-Design: Materials and colours listed below form the Basis-of-Design materials for this project.
- .2 Materials other than named products Basis-of-Design materials may be acceptable to the Consultant; submit information in accordance with Section 01 62 00 – Product Options no later than seven (7) days prior to bid closing date and as follows:
 - .1 Proposed alternates shall match colour range, texture and performance characteristics of named products, and shall not require a change to colour board for Project.
 - .2 Proposed alternates found acceptable by Consultant will be listed in an Addendum.
 - .3 The Consultant is not obliged to accept any materials presented for their review and does not need to provide reasons for rejection of proposed alternates.

2.2 RESILIENT BASE

- .1 Resilient Base: to ASTM F1861, and as follows:
 - .1 Type: TP – rubber, thermoplastic
 - .2 Group: 1 – solid.
 - .3 Style: B – Cove.
 - .4 Thickness: 2.03 mm.
 - .5 Length: 36.5 meter rolls.
 - .6 End Stops and External Corners: premoulded.
 - .7 Basis of Design:
 - .1 Masquerade Contoured Wall Base and Perceptions Designer Wall Base, Johnsonite

2.3 ACCESSORIES

- .1 Primers and adhesives: of types recommended by resilient flooring manufacturer for specific material on applicable substrate, above, on or below grade.
 - .1 Cove base adhesives:
 - .1 Adhesive: maximum VOC limit 50 g/L to SCAQMD Rule 1168.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 SITE VERIFICATION OF CONDITIONS

- .1 Ensure concrete floors have maximum 2.5% moisture content, exhibit normal alkalinity and no carbonization or dusting.
- .2 Ensure concrete floors are clean, smooth, and flat to plus or minus 3 mm over 3 meters.

3.3 PREPARATION

- .1 Remove or treat old adhesives to prevent residual, old flooring adhesives from bleeding through to new flooring and/or interfering with the bonding of new adhesives.

3.4 INSTALLATION: GENERAL

- .1 Provide high ventilation rate, with maximum outside air, during installation, and for 48 to 72 hours after installation. If possible, vent directly to outside. Do not let contaminated air recirculate through district or whole building air distribution system. Maintain extra ventilation for at least one month following building occupation.
- .2 Apply adhesive uniformly using recommended trowel in accordance with flooring manufacturer's instructions. Do not spread more adhesive than can be covered by flooring before initial set takes place.

3.5 INSTALLATION: BASE

- .1 Lay out base to keep number of joints at minimum.
- .2 Clean substrate and prime with one coat of adhesive.
- .3 Apply adhesive to back of base.
- .4 Set base against wall and floor surfaces tightly by using 3 kg hand roller.
- .5 Install straight and level to variation of 1:1000.
- .6 Scribe and fit to door frames and other obstructions. Use premoulded end pieces at flush door frames.
- .7 Cope internal corners. Use premoulded corner units for right angle external corners. Use formed straight base material for external corners of other angles.
- .8 Heat weld base in accordance with manufacturer's printed instructions.

3.6 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

3.7 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Remove excess adhesive from floor, base and wall surfaces without damage.
- .3 Clean, seal and wax floor and base surface to flooring manufacturer's printed instructions.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 This Section includes resinous flooring systems with epoxy body and covered base.

1.2 RELATED SECTIONS

- .1 Section 03 35 00 – Concrete Finishing
- .2 Section 07 92 00 – Sealants

1.3 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM C579-01(2012), Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing's, and Polymer Concretes.
 - .2 ASTM C307-03 (2008), Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacing's.
 - .3 ASTM C580-02 (2008), Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing's, and Polymer Concretes.
 - .4 ASTM C413-01 (2006), Standard Test Method for Absorption of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacing's.
 - .5 ASTM D2794-93(2010), Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
 - .6 ASTM E648
 - .7 ASTM D2240-05(2010), Standard Test Method for Rubber Property – Durometer Hardness.
 - .8 ASTM F2170-11, Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.
 - .9 ASTM F1869-11, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.

1.4 ADMINISTRATIVE REQUIREMENTS

- .1 Convene pre-installation meeting one week prior to beginning work of this Section, with Contractor, Departmental Representative, installer, manufacturer's representative to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.

1.5 SUBMITTALS

- .1 Submit product data in accordance with Section 01 11 00 – General Requirements - Submittals.

- .1 Submit manufacturer's technical data, application instructions, and general recommendations for each resinous flooring material required.
- .2 Submit samples in accordance with Section 01 11 00 – General Requirements - Submittals:
 - .1 Verification Sample: submit 150 mm x 150 mm samples of each type of resinous flooring required, applied to a rigid backing, in color and finish indicated.
- .3 Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.
- .4 Manufacturer's Field Reports: submit to manufacturer's written reports within 3 days of review, verifying compliance of Work, as described in PART 3 - FIELD QUALITY CONTROL.
- .5 Closeout Submittals: Submit in accordance with Section 01 78 00 – Closeout Submittals.
 - .1 Submit copies of manufacturer's written maintenance information for inclusion in the operations manual including specific warning of any maintenance practice or materials that may damage or disfigure the finished Work.

1.6 QUALITY ASSURANCE

- .1 Single-Source Responsibility: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, through one source from a single manufacturer. Provide secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from source recommended by manufacturer of primary materials.
- .2 Qualifications: Provide proof of qualifications when requested by Departmental Representative:
 - .1 Manufacturers: Obtain primary materials from a single manufacture with experience in manufacturing and installing principal materials described in this section.
 - .2 Applicators: Use experienced applicators as approved by materials manufacturer whose work has a record of successful in service performance.
- .3 Regulatory Requirements: materials, including primers, resins, curing agents, finish coats, aggregates and sealants are manufactured and tested under an ISO 9001 registered quality system.

1.7 MOCK-UPS

- .1 Provide required mock-up in accordance with Section 01 45 00 – Quality Control and as follows:
 - .1 Apply mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - .2 Apply full-thickness mockups on 10 m² floor area selected by Departmental Representative.
 - .3 Include 1 m length of integral cove base.

- .4 Reviewed mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE AND HANDLING

- .1 Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.
- .2 Store materials to prevent deterioration from moisture, heat, cold, direct sunlight, or other detrimental effects.
- .3 Materials used shall be factory pre-weighed and pre-packaged in single, easy to manage batches to eliminate on site mixing errors. No on-site weighing or volumetric measurements allowed.

1.9 PROJECT CONDITIONS

- .1 Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.
- .2 Maintain material and substrate temperature between 18°C and 30°C during resinous flooring application and for not less than 24 hours after application.
- .3 Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.
- .4 Close spaces to traffic during resinous flooring application and for not less than 24 hours after application, unless manufacturer recommends a longer period.
- .5 Concrete substrate shall be properly cured for a minimum of 30 days. A vapor barrier must be present for concrete subfloors on or below grade. Otherwise, an osmotic pressure resistant grout must be installed on a unit-price basis prior to the resinous flooring

1.10 WARRANTY

- .1 Provide manufacturer's written warranty covering both material and workmanship for a period of one (1) one full year from date of Substantial Completion, or provide a joint and several warranty signed on a single document by material manufacturer and applicator jointly and severally warranting the materials and workmanship for a period of (1) one full year from date of Substantial Completion.

Part 2 Products

2.1 MATERIALS

- .1 Resinous Flooring: troweled mortar base with broadcast topping. Liquid rich, slurry type systems will not be accepted.
 - .1 System Characteristics:
 - .1 Colour and Pattern: as indicated in Finish Schedule or as selected by Departmental Representative from manufacturer's standards.
 - .2 Wearing Surface: medium

- .3 Integral Cove Base: as indicated in Finish Schedule or as directed by Departmental Representative
- .4 Overall System Thickness: nominal 6 mm
- .2 System Components: Manufacturer's standard components that are compatible with each other and as follows:
 - .1 Primer:
 - .1 Material Basis-of-Design: Stonhard Standard Primer.
 - .2 Resin: epoxy
 - .3 Formulation Description: two component, 100 percent solids.
 - .4 Application Method: squeegee and roller.
 - .5 Number of Coats: one.
 - .2 Mortar Base:
 - .1 Material Basis-of-Design: Stonshield HRI Base
 - .2 Resin: epoxy
 - .3 Formulation Description: three component, 100 percent solids.
 - .4 Application Method: metal trowel.
 - .1 Thickness of Coats: nominal 4 mm.
 - .2 Number of Coats: one.
 - .5 Aggregates: pigmented blended aggregate.
 - .3 Undercoat:
 - .1 Material Basis-of-Design: Stonshield undercoat
 - .2 Resin: epoxy
 - .3 Formulation Description: two-component, 100% solids, UV stable.
 - .4 Type: clear.
 - .5 Finish: gloss.
 - .6 Number of Coats: one.
 - .4 Broadcast Media:
 - .1 Material Basis: Stonshield quartz aggregate.
 - .2 Type: pigmented.
 - .3 Number of Coats: one.
 - .4 Pattern: confirm with Departmental Representative.
 - .5 Sealer:
 - .1 Material Basis-of-Design: Stonshield Sealer.
 - .2 Resin: epoxy
 - .3 Formulation Description: two-component, 100% solids, UV stable.
 - .4 Type: clear.
 - .5 Finish: flat.
 - .6 Number of Coats: one.
 - .7 Texture level: medium.

- .3 System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:
 - .1 Compressive Strength: 10,000 psi after 7 days per ASTM C579.
 - .2 Tensile Strength: 2,000 psi per ASTM C307.
 - .3 Flexural Strength: 4,300 psi per ASTM C580.
 - .4 Water Absorption: < 1% per ASTM C413.
 - .5 Impact Resistance: > 160 in. lbs. per ASTM D2794.
 - .6 Flammability: Class 1 per ASTM E648.
 - .7 Hardness: 85 to 90, Shore D per ASTM D2240.
- .4 Basis-of-Design:
 - .1 Stonhard, Stonshield HRI®

2.2 ACCESSORIES

- .1 Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended by manufacturer for application indicated.
- .2 Joint Sealant: Type recommended or produced by resinous flooring manufacturer for type of service and joint condition indicated.

Part 3 Execution

3.1 PREPARATION

- .1 General: Prepare and clean substrates according to resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry, and neutral Ph substrate for resinous flooring application.
- .2 Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.
 - .1 Mechanically prepare substrates as follows:
 - .1 Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
 - .2 Comply with ASTM C811 requirements, unless manufacturer's written instructions are more stringent.
 - .2 Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written recommendations.
 - .3 Verify that concrete substrates are dry.
 - .1 Perform in situ probe test, ASTM F2170. Proceed with application only after substrates do not exceed a maximum potential equilibrium relative humidity of 75 percent.
 - .2 Perform anhydrous calcium chloride test, ASTM F1869. Proceed with application only after substrates have maximum moisture-vapor-emission rate of 5 lb of water/1000 sq. ft. of slab in 24 hours.

- .3 Perform additional moisture tests recommended by manufacturer. Proceed with application only after substrates pass testing.
 - .4 Verify that concrete substrates have neutral Ph and that resinous flooring will adhere to them. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.
 - .3 Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.
 - .4 Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.
 - .5 Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written recommendations.

3.2 APPLICATION

- .1 General: Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.
 - .1 Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
 - .2 Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
 - .3 At substrate expansion and isolation joints, provide joint in resinous flooring to comply with resinous flooring manufacturer's written recommendations.
 - .1 Apply joint sealant to comply with manufacturer's written recommendations.
- .2 Apply primer where required by resinous system, over prepared substrate at manufacturer's recommended spreading rate.
- .3 Integral Cove Base: apply cove base mix to wall surfaces before applying flooring. Apply according to manufacturer's written instructions and details including those for taping, mixing, priming, troweling, sanding, of cove base. Round internal and external corners.
- .4 Apply metal trowel single mortar coat in thickness indicated for flooring system. Hand or power trowel and grout to fill voids. When cured, sand to remove trowel marks and roughness.
- .5 Undercoat: Remove any surface irregularities by lightly abrading and vacuuming the floor surface. Mix and apply undercoat with strict adherence to manufacturer's installation procedures and coverage rates.
- .6 Broadcast Media: Immediately broadcast quartz silica aggregate into the undercoat using manufacturer's specially designed spray caster. Strict adherence to manufacturer's installation procedures and coverage rates is imperative.
- .7 Apply topcoat(s) in number of coats indicated for flooring system and at spreading rates recommended in writing by manufacturer.

3.3 TERMINATIONS

- .1 Chase edges to “lock” the coating system into the concrete substrate along lines of termination.
- .2 Penetration Treatment: Lap and seal coating onto the perimeter of the penetrating item by bridging over compatible elastomer at the interface to compensate for possible movement.
- .3 Trenches: Continue coating system into trenches to maintain monolithic protection. Treat cold joints to assure bridging of potential cracks.
- .4 Treat floor drains by chasing the coating to lock in place at point of termination.

3.4 JOINTS AND CRACKS

- .1 Treat control joints to bridge potential cracks and to maintain monolithic protection.
- .2 Treat cold joints and construction joints to bridge potential cracks and to maintain monolithic protection on horizontal and vertical surfaces as well as horizontal and vertical interfaces.
- .3 Discontinue floor coating system at vertical and horizontal contraction and expansion joints by installing backer rod and compatible sealant after coating installation is completed. Provide sealant type recommended by manufacturer for traffic conditions and chemical exposures to be encountered.

3.5 FIELD QUALITY CONTROL

- .1 Have manufacturer of products supplied under this Section review Work involved in handling, installation/application, protection and cleaning of its products, and submit written reports in acceptable format to verify compliance of Work with Contract.
- .2 Manufacturer's field services: provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
- .3 Schedule site visits to review Work at stages listed:
 - .1 After delivery and storage of products, and when preparatory Work on which Work of this Section depends is complete, but before installation begins.
 - .2 Twice during progress of Work at 25% and 60% complete.
 - .3 Upon completion of Work, after cleaning is carried out.
- .4 Obtain reports within three days of review and submit.
- .5 Material Sampling: Owner may at any time and any numbers of times during resinous flooring application require material samples for testing for compliance with requirements.
 - .1 Owner will engage an independent testing agency to take samples of materials being used. Material samples will be taken, identified, sealed, and certified in presence of Contractor.
 - .2 Testing agency will test samples for compliance with requirements, using applicable referenced testing procedures or, if not referenced, using testing procedures listed in manufacturer's product data.

- .3 If test results show applied materials do not comply with specified requirements, pay for testing, remove noncomplying materials, prepare surfaces coated with unacceptable materials, and reapply flooring materials to comply with requirements.

3.6 CURING, PROTECTION AND CLEANING

- .1 Cure resinous flooring materials in compliance with manufacturer's directions, taking care to prevent contamination during stages of application and prior to completion of curing process. Close area of application for a minimum of 18 hours after application.
- .2 Protect resinous flooring materials from damage and wear during construction operation. Where temporary covering is required for this purpose, comply with manufacturer's recommendations for protective materials and method of application.
- .3 Cleaning: Remove temporary covering and clean resinous flooring just prior to final inspection. Use cleaning materials and procedures recommended by resinous flooring manufacturer.
- .4 Protect and clean surfaces after final coats.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Provide labour, materials, tools and other equipment, services and supervision required to complete interior and exterior, including above roof, painting and decorating work.
- .2 Surface preparation for this section will be limited to priming and back-priming, and specific pre-treatments noted in this section or as specified in the Master Painters Institute (MPI) Painting Specification Manual.

1.2 RELATED REQUIREMENTS

- .1 Other sections of the specification requiring painting refer to this section. Coordinate requirements of referencing sections.

1.3 REFERENCE STANDARDS

- .1 Environmental Choice Program ([ECP](#)):
 - .1 Paints and Surface Coatings, Low VOC Product Listings
- .2 The Master Painters Institute ([MPI](#)):
 - .1 New Surfaces: Architectural Painting Specification Manual.
 - .2 Existing Surfaces: Interior Maintenance Repainting Manuals.
- .3 The Society for Protective Coatings ([SSPC](#)):
 - .1 Coating Materials Guidelines
 - .2 Surface Preparation Guidelines
 - .3 Application, Inspection and Quality Control Guidelines

1.4 DEFINITIONS

- .1 Gloss Levels: Standard coating terms defined by MPI Manual apply to products of this Section as follows, and are used on Drawing or as indicated in this Section to designate required gloss levels for indicated areas:
 - .1 G1 – Matte Finish (flat): Matte to low sheen finish with a gloss range of 0 to 10 when measured at 85° to meter and 0 to 5 when measured at 60°.
 - .2 G2 – Velvet: Matte to low sheen finish with a gloss range of 10 to 35 when measured at 85° to meter and 0 to 10 when measured at 60°.
 - .3 G3 – Eggshell: Low sheen finish with a gloss range of 10 to 35 when measured at 85° to meter and 10 to 25 when measured at 60°.
 - .4 G4 – Satin: Low to medium sheen with a gloss range of minimum 35 when measured at 85° to meter and 20 to 35 when measured at 60°.
 - .5 G5 – Semi-Gloss: Medium sheen finish with a gloss range of 35 to 70 when measured at 60° to meter.

1.5 SUBMITTALS

- .1 Provide required information in accordance with Section 01 11 10 – General Requirements: Submittals.

- .2 Action Submittals: Provide the following submittals before starting any work of this Section:
 - .1 Product Data: Submit list of all painting materials used for the Work to the Departmental Representative for review prior to ordering materials for each paint system indicated, including block fillers and primers:
 - .1 Material List: An inclusive list of required coating materials indicating each material and cross reference specific coating, finish system, and application; identify each material by manufacturer's catalogue number and general classification.
 - .2 Base Information: Confirmation of manufacturer's ability to supply paint in a variety of base tints, specific to the range of colours being used on this project; indicate colour of base tint used and amount of colourant added to establish Scheduled colours.
 - .3 Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material.
 - .2 Samples: Provide stepped samples, defining each separate coat, including block fillers and primers using representative colours required for the project; label each sample for location and application, and as follows:
 - .1 Samples for Verification: When requested by the Departmental Representative, provide samples for each colour and material, with texture to simulate actual conditions, on representative samples of the actual substrate as follows:
 - .1 Painted Wood: 200 mm long or square samples for each colour and material on representative sample wood used for the Work.
 - .2 Stained or Natural Wood: 200 mm long or square samples of natural or stained wood finish on representative species of wood used for the Work.
 - .3 Painted Gypsum Board: 200 mm long or square samples for each colour and material.
 - .3 Informational Submittals: Provide the following submittals when requested by the Departmental Representative:
 - .1 Certification: Submit certification reports for paint products indicating that they meet or exceed low VOC and coloured base requirements listed in this Section.
 - .2 Purchase Orders: Retain purchase orders, invoices and other documents for verification of compliance with specification and design requirements.

1.6 PROJECT CLOSEOUT SUBMISSIONS

- .1 Operation and Maintenance Data: Submit copies of paint manufacturer's written maintenance information for inclusion in the operations manual in accordance with Section 01 11 10 – General Requirements including specific warning of any maintenance practice or materials that may damage or disfigure the finished Work.

1.7 QUALITY ASSURANCE

- .1 Conform to the standards contained in the MPI Manual.
- .2 Applicator Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in service performance, and as follows:
 - .1 Have proven satisfactory experience and shall show proof before commencement of work that he will maintain a qualified crew of painters throughout the duration of the work.
 - .2 When requested provide a list of the last three comparable jobs including, name and location, specifying authority, start and completion dates and cost amount of the painting work.
 - .3 Only qualified journeymen who have a Tradesman Qualification Certificate of Proficiency shall be engaged in painting and decorating work.
 - .4 Apprentices may be employed provided they work under the direct supervision of a qualified journeyman in accordance with trade regulations.

1.8 ENVIRONMENTAL REQUIREMENTS

- .1 Conform to MPI Manual and manufacturer's requirements.
- .2 Perform no painting or decorating work when the ambient air and substrate temperatures, relative humidity and dew point and substrate moisture content is below or above requirements for both interior and exterior work.
- .3 Apply paint only to dry, clean, properly cured and adequately prepared surfaces in areas where dust is no longer generated by construction activities such that airborne particles will not affect the quality of finished surfaces.
- .4 Ensure adequate continuous ventilation and sufficient heating and lighting is in place.
- .5 Paint, stain and wood preservative finishes and related materials (thinners, solvents, caulking, empty paint cans, cleaning rags, etc.) shall be regarded as hazardous products. Recycle and dispose of same subject to regulations of applicable authorities having jurisdiction.
- .6 To reduce the amount of contaminants entering waterways, sanitary/storm drain systems or into the ground retain cleaning water and filter out and properly dispose of sediments.
- .7 Set aside and protect surplus and uncontaminated finish materials not required by the Owner and deliver or arrange collection for verifiable re-use or re-manufacturing.

Part 2 Products

2.1 MATERIALS

- .1 Primers, paints, coatings, varnishes, stains, lacquers, fillers, thinners, solvents, and other painting materials shall be in accordance with the MPI Manual

“Approved Product” listing and shall be from a single manufacturer for each system used.

- .2 Materials such as linseed oil, shellac, and other accessory materials shall be the highest quality product of an approved manufacturer listed in the MPI Manual and shall be compatible with other coating materials.
- .3 All materials and paints shall be lead and mercury free and shall have low VOC content where possible.

Part 3 Execution

3.1 PREPARATION OF SURFACES:

- .1 Prepare surfaces in accordance with MPI Manual requirements. Refer to the Manual for specific surface preparation requirements for each substrate material.

3.2 APPLICATION

- .1 Paint when substrates and environmental conditions (heating, ventilation, lighting and completion of other work) are acceptable for applications of products specified in this Section.
- .2 Paint surfaces requiring paint or stain finish to Premium MPI Manual finish requirements with application methods in accordance with best trade practices for type and application of materials used.
- .3 Continue paint finishes through behind wall mounted items.
- .4 Painting coats specified are intended to cover surfaces satisfactorily when applied at proper consistency and in accordance with manufacturer's recommendations.
- .5 Apply a minimum of four coats of paint where deep or bright colours are used to achieve satisfactory results.

3.3 EXTERIOR SURFACES

- .1 Unless otherwise specified, all exterior painting work to be in accordance with MPI Premium Grade finish requirements.
- .2 Concrete Vertical Surfaces: (including horizontal soffits):
 - .1 EXT 3.1A - Latex gloss level as directed.
- .3 Structural Steel and Metal Fabrications: columns, beams, joists and miscellaneous metal:
 - .1 EXT 5.1R Water Based Light Industrial - gloss level as directed (over H.B. Epoxy).
- .4 Steel - High Heat: heat exchangers, breeching, pipes, flues, stacks, etc., with temperature range as noted:
 - .1 EXT 5.2A - Heat resistant enamel finish, maximum 205 degrees C.
 - .2 EXT 5.2B - Heat resistant aluminum enamel finish, maximum 427 degrees C.
 - .3 EXT 5.2C - Inorganic zinc rich coating, maximum 400 degrees C.
 - .4 EXT 5.2D - High heat resistant coating, maximum 593 degrees C.

- .5 Galvanized Metal: non chromate passivated; high contact/high traffic areas (doors, frames, railings and handrails, etc.):
 - .1 EXT 5.3J – Water Based Light Industrial - gloss level as directed (over epoxy)
- .6 Aluminum: sash, sills and frames, flashing, posts and railings, downpipes, etc.:
 - .1 EXT 5.4G - Waterborne light industrial gloss level as directed
- .7 Dimension Lumber: columns, beams, exposed joists, underside of decking, siding, fencing, etc.:
 - .1 EXT 6.2L - Semi-transparent stain finish.
 - .2 Two coats, exterior alkyd translucent satin wood finish: Cetol® Log & Siding, Sikkens, or similar with same or better material properties and performance characteristics.
 - .1 Colour(s): as selected by Consultant for manufacturer's full range.
- .8 Dressed Lumber: doors, door and window frames, casings, battens, smooth facias, etc.:
 - .1 EXT 6.3B - Alkyd gloss level as directed.
- .9 Bituminous Coated Surfaces: cast iron pipe, concrete, etc.:
 - .1 EXT 10.2A - Latex gloss level as directed.

3.4 INTERIOR SURFACES

- .1 Paint interior surfaces in accordance with the MPI Manual painting systems listed in this section.
- .2 Structural Steel and Metal Fabrications: columns, beams, joists and miscellaneous metal:
 - .1 INT 5.1E Alkyd - gloss level as directed.
- .3 Galvanized Metal (doors, frames, railings, misc. steel, pipes, overhead decking, ducts, etcetera):
 - .1 INT 5.3C - Alkyd gloss level as directed (over cementitious primer).
- .4 Dressed Lumber (including doors, door and window frames, casings, mouldings, etcetera):
 - .1 INT 6.2H - Polyurethane varnish [like stain cloth] level finish.
- .5 Plaster and Gypsum Board (gypsum board, drywall, and other sheet gypsum materials):
 - .1 INT 9.2B – High performance architectural latex semi-gloss finish.

3.5 MECHANICAL / ELECTRICAL EQUIPMENT AND RELATED SURFACES:

- .1 Unless otherwise specified or noted, paint all “unfinished” conduits, piping, hangers, ductwork and other mechanical and electrical equipment with colour and texture to match adjacent surfaces, in the following areas:
 - .1 where exposed-to-view in all exterior and interior areas.
 - .2 in all interior high humidity interior areas.

- .3 in all boiler room, mechanical and electrical rooms.
- .2 In unfinished areas leave exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment in original finish and touch up scratches and marks.
- .3 Touch up scratches and marks on factory painted finishes and equipment with paint as supplied by manufacturer of equipment.
- .4 Do not paint over nameplates.
- .5 Paint the inside of all ductwork where visible behind louvers, grilles and diffusers for a minimum of 460 mm (18") or beyond sight line, whichever is greater, with primer and one coat of matt black (non-reflecting) paint.

3.6 MAINTENANCE REPAINTING

- .1 Paint existing interior previously finishes surfaces in accordance with the MPI Manual painting systems listed in this section.

3.7 SITE QUALITY CONTROL

- .1 Painted surfaces will be considered to lack uniformity and soundness if any of the following defects are apparent at time of field review when viewed from a distance of 1220 mm from the painted surface:
 - .1 Runs, sags, hiding or shadowing by inefficient application methods
 - .2 Evidence of poor coverage at rivet heads, plate edges, lap joints, crevices, pockets, corners and re-entrant angles
- .2 Painted surfaces will be considered as deficient if any of the following defects are apparent at time of field review, regardless of viewing distance.
 - .1 Damage due to touching before paint is sufficiently dry or any other contributory cause.
 - .2 Damage due to application on moist surfaces or caused by inadequate protection from the weather.
 - .3 Damage or contamination of paint due to windblown contaminants (dust, sand blast materials, salt spray, etcetera)
- .3 Painted surfaces found as unacceptable shall be replaced or repaired at no cost to the Owner or Departmental Representative:
 - .1 Small affected areas may be touched up
 - .2 Large affected areas or areas without sufficient dry film thickness of paint shall be repainted.
 - .3 Runs, sags or damaged paint shall be removed by scraper or by sanding before application of new paint coats.

3.8 PROTECTION

- .1 Protect newly painted exterior surfaces from rain and snow, condensation, contamination, dust, salt spray and freezing temperatures until paint coatings are completely dry.
- .2 Curing periods shall exceed the manufacturer's recommended minimum time requirements.

- .3 Erect barriers or screens and post signs to warn of or limit or direct traffic away or around work area as required.

3.9 RESTORATION

- .1 Clean and re-install all hardware items that were removed before painting operations were undertaken, ensuring that tagged or labelled items are returned to the exact position from which they were removed.
- .2 Clean, prime and re-paint all bolts, nuts and fasteners after torquing or re-tightening following specified paint finish.
- .3 Remove protective coverings and warning signs as soon as possible after operations cease.
- .4 Protect freshly painted surfaces from paint droppings and dust to approval of Departmental Representative. Avoid scuffing newly applied paint.
- .5 Restore areas used for storage, cleaning, mixing and handling of paint to clean condition as approved by Departmental Representative.

3.10 CLEANUP

- .1 Remove all paint where spilled, splashed, splattered or sprayed as work progresses using means and materials that are not detrimental to affected surfaces.
- .2 Keep work area free from an unnecessary accumulation of tools, equipment, surplus materials and debris.
- .3 Remove combustible rubbish materials and empty paint cans each day and safely dispose of it in accordance with requirements of authorities having jurisdiction.
- .4 Clean equipment and dispose of wash water or solvents, and other cleaning and protective materials (rags, drop cloths, masking papers, etcetera), paints, thinners, paint removers and strippers in accordance with the safety requirements of authorities having jurisdiction.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 06 10 00 - Rough Carpentry.
- .2 Section 09 21 16 - Gypsum Board Assemblies

1.2 REFERENCES

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM E84-18a, Test for Surface Burning Characteristics of Building Materials.

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

- .1 Product Data.
 - .1 Submit manufacturer's printed product literature, specifications and data sheet in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Submit two copies of WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 33 00 - Submittal Procedures. Indicate VOC's:
 - .1 For caulking materials during application and curing.
 - .2 For adhesives.
- .2 Shop Drawings.
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Indicate, by large scale details, materials, finishes, dimensions, anchorage and assembly.
- .3 Samples.
 - .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Submit duplicate 300 mm long samples of profiles and colours for corner and door frame.
- .4 Manufacturer's Instructions.
 - .1 Submit manufacturer's installation instructions.

1.4 QUALITY ASSURANCE

- .1 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .3 Pre-Installation Meetings: conduct pre-installation meeting to verify project requirements, manufacturer's installation instructions and manufacturer's warranty requirements.

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

- .1 Wall Panels:
 - .1 Type: fibre reinforced panel to USDA/FSIS and Canadian Food Inspection Agency and Agriculture Canada approved.
 - .2 Dimensions: 2.4 mm thick x 1220 mm x 2440 mm
 - .3 Texture: smooth
 - .4 Fire Rating: Class I/A
 - .5 Colour: as directed by Consultant from manufacturers standard range
 - .6 Acceptable Materials:
 - .1 Altrorock
 - .2 Panolam
 - .3 Marlite FRP Wall Panels
 - .4 Sequentia, Thermo Design

2.2 ACCESSORIES

- .1 Adhesive: water resistant type as recommended by manufacturer for substrate.
- .2 Sealant: Manufacturer's recommended silicone sealant; colour matched to panels.
- .3 Fastenings: Nylon drive rivets or stainless steel screws as recommended by manufacturer.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

3.2 INSTALLATION

- .1 Install panels in accordance with manufacturer's written instructions; maintain a reference copy of installation instructions on site for review by installers and the Consultant.
- .2 Position panels leaving a minimum 6 mm gap at ceiling and floor junction; minimum 3 mm gap between each panel and division bar moulding to allow for normal expansion and contraction; minimum 3 mm gap around pipes, electrical fittings, other projections; and pre-drill oversize by 3 mm holes ready for fastenings.

- .3 Cut and drill panels using a carbide tipped saw blade or drill bit; or cut with snips as recommended by manufacturer.
- .4 Pre-fit each panel before securing in place; leave leading edge of first panel unfastened; trim division bar to accommodate ceiling cove or base moulding:
 - .1 Apply bead of silicone sealant on one side of division bar and install on leading edge of first panel.
 - .2 Push division bar all the way onto panel and pull back to form a minimum 3 mm gap; confirm plumb; tack division bar using fasteners recommended by manufacturer.
 - .3 Fasten leading edge of first panel.
- .5 Install fasteners at nominal 400 mm o.c. both horizontally and vertically. Maintain edge fasteners 25 mm from panel edge face.
- .6 Stagger fasteners on opposing panel edges and corners next to a division bar to aid in maintaining tight, flat seam.
- .7 Use combination of mechanical fasteners and adhesive to ensure flat surface, using compatible adhesives recommended by panel manufacturer prior:
 - .1 Fasten panel at top and work toward bottom or start at centre and work outward.
 - .2 After installation of first panel is completed remove excess sealant immediately.
 - .3 Apply bead of sealant in remaining channel of division bar.
 - .4 Install second panel into division bar.
 - .5 Pull panel back to leave a minimum 3 mm clearance.
 - .6 Check plumb.
 - .7 Remove excess sealant.
 - .8 Fasten second panel except for leading edge.
 - .9 Repeat previous steps until all panels are installed.
- .8 Remove excess silicone sealant during installation.
- .9 Seal corner seams, ceiling, and base junctions; install accessories as installation progresses, leaving a minimum 3 mm clearance for normal expansion and contraction of panels.
- .10 Cut trims neatly, use only full length except where joins are permitted by Consultant; tightly mitre trims at right angle corners; tightly cut trims at Tee junctions to maintain flush straight fit.

3.3 CLEANING

- .1 Perform cleaning after installation to remove construction and accumulated environmental dirt.
- .2 Clean surfaces after installation using manufacturer's recommended cleaning procedures.
- .3 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 08 80 50 - Glazing: Mirrors.

1.2 REFERENCES

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM A153/A153M-16a, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - .2 ASTM A167-99 (2009), Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 - .3 ASTM A653/A653M-15e1, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .4 ASTM A666-15, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
 - .5 ASTM A924/A924M-16ae1, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
 - .6 ASTM A1008/A1008M-16, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
 - .7 ASTM B16/B16M-10 (2015), Standard Specifications for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines.
 - .8 ASTM B19-15, Standard Specification for Cartridge Brass Sheet, Strip, Plate, Bar, and Disks.
 - .9 ASTM B456-11e1, Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium.
 - .10 ASTM C1503 -08(2013), Standard Specification for Silvered Flat Glass Mirror.
- .2 Canadian Standards Association (CSA)
 - .1 CSA-B651-12, Accessible Design for the Built Environment.
 - .2 CAN/CSA-G164-M92 (R2003), Hot Dip Galvanizing of Irregularly Shaped Articles.

1.3 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittals:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet.
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittals:
 - .1 Indicate size and description of components, base material, surface finish inside and out, hardware and locks, attachment devices, description of rough-in-frame, building-in details of anchors for grab bars.
- .3 Submit samples in accordance with Section 01 33 00 – Submittals:
 - .1 Samples to be returned for inclusion into work.

- .4 Submit closeout data in accordance with Section 01 78 00 – Closeout Submittals:
 - .1 Provide maintenance data for toilet and bath accessories for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
 - .2 Include list of sources for disposable supplies, replacement parts and service recommendations.

1.4 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Waste Management and Disposal.

1.5 EXTRA MATERIALS

- .1 Provide special tools required for accessing, assembly/disassembly or removal for toilet and bath accessories in accordance with requirements specified in Section 01 78 00 - Closeout Submittals.
- .2 Deliver special tools to Departmental Representative.

Part 2 Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturers: subject to compliance with requirements specified in this Section and as established by the basis-of-design materials, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - .1 ASI Specialties Inc.
 - .2 Bobrick Washroom Equipment of Canada Ltd.
 - .3 Bradley Corporation.
 - .4 Frost

2.2 MATERIALS

- .1 Sheet steel: to ASTM A653/A653M cold rolled, commercial quality, 0.912 mm minimum nominal thickness, with ZF001 designation zinc coating.
- .2 Stainless steel sheet metal: to ASTM A666, Type 304, finish as indicated in component list in 1.519 mm minimum nominal thickness.
- .3 Stainless steel tubing: Type 304, commercial grade, seamless welded, 1.2 mm wall thickness.
- .4 Fasteners: concealed screws and bolts hot dip galvanized after fabrication, tamper and theft resistant exposed fasteners to match material of unit. Expansion shields fibre, lead or rubber as recommended by accessory manufacturer for component and its intended use.

2.3 COMPONENTS

- .1 Toilet tissue dispenser (jumbo roll type): holds twin jumbo rolls, surface mounted, stainless steel construction, equipped with tumbler lock, accommodates two rolls of 228 mm diameter minimum with satin finish.
 - .1 Acceptable materials:

- .1 5425, Bradley.
- .2 Combination towel dispenser/waste receptacle: Surface mount wall unit, approximately 435 mm wide, 1420 mm high, 373 mm deep of stainless steel construction. Suitable for dispensing jumbo roll towels (203 mm wide x 203 mm diameter) operated by manual push bar requiring less than 2.3 kg of force, with hinged service door with keyed tumbler lock. Waste receptacle removable from cabinet with keyed tumbler lock. Universal keying. Formed from stainless steel sheet with satin finish on exposed surfaces, fully welded, with seamless corners and burr free edges: cabinet and flange 0.76 mm thick; door and waste receptacle 0.91 mm thick.
 - .1 Acceptable materials:
 - .1 2A15-1136, Bradley
- .3 Soap dispenser: liquid push-in valve, self contained 1.14 L tank, stainless steel piston and valve assembly, refillable from top, tamper proof keyed lock, vertical surface mounted, stainless steel construction with satin finish on exposed surfaces. Requires less than 2.3 kg of force to dispense soap.
 - .1 Acceptable materials:
 - .1 6560, Bradley
- .4 Hand Dryer: listed under re-examination service of ULC and CSA approved and as follows:
 - .1 Surface mounted, 115 Volt AC, 12.5 Amp, 900 Watts, 60 Hz, automatic sensor cycle warm air hand dryer, GREENSPEC approved and LEED Rated.
 - .2 Mounting height: as required by Manufacturer.
 - .3 Acceptable materials:
 - .1 Airblade, Dyson.
- .5 Sanitary napkin disposal unit: stainless steel construction with satin finish, recessed unit with self-trimming flange. Equipped with push flap door with concealed hinges, hinged drop-down service door with keyed tumbler lock, and removable waste container. Universal keying.
 - .1 Overall dimensions: 313 mm wide x 376 mm high x 1460 mm deep.
 - .2 Acceptable materials:
 - .1 4A00, Bradley
- .6 Diaper changing station: recessed wall unit, bacteria resistant polyethylene body with brushed stainless steel exterior, liner dispenser, safety belt, and graphic illustration, labeled with universally accepted symbol "changing station".
 - .1 Overall dimensions: 953 mm wide x 549 mm high x 102 mm deep.
 - .2 Mounting height: as required by Manufacturer.
 - .3 Acceptable materials:
 - .1 962, Bradley
- .7 Coat hook: stainless steel with satin finish, square profile, concealed mounting with approximately 40 mm projection.
 - .1 Acceptable materials:
 - .1 9114, Bradley

2.4 FABRICATION

- .1 Weld and grind joints of fabricated components flush and smooth. Use mechanical fasteners only where approved.
- .2 Wherever possible form exposed surfaces from one sheet of stock, free of joints.
- .3 Brake form sheet metal work with 1.5 mm radius bends.
- .4 Form surfaces flat without distortion. Maintain flat surfaces without scratches or dents.
- .5 Back paint components where contact is made with building finishes to prevent electrolysis.
- .6 Hot dip galvanize concealed ferrous metal anchors and fastening devices to CSA G164.
- .7 Shop assemble components and package complete with anchors and fittings.
- .8 Deliver inserts and rough-in frames to job site at appropriate time for building-in. Provide templates, details and instructions for building in anchors and inserts.
- .9 Provide steel anchor plates and components for installation on studding and building framing.

2.5 FINISHES

- .1 Chrome and nickel plating: to ASTM B456, satin finish.
- .2 Labels: Non-exposed faces, provide maximum 38 mm diameter stamped manufacturer logo.

Part 3 Execution

3.1 PREPARATION

- .1 Verify wall thickness and construction that will accept recessed accessories.
- .2 Verify that solid blocking for support and anchoring of washroom accessories is installed where required. Confirm exact height and location with Departmental Representative and Manufacturers Instructions.
- .3 Verify that frames and anchors provided, whether by this Section or others, are correctly and securely installed ready to accept the accessory scheduled for the specific location.
- .4 Verify that painting is complete and dry in area of installation before accessories are installed.

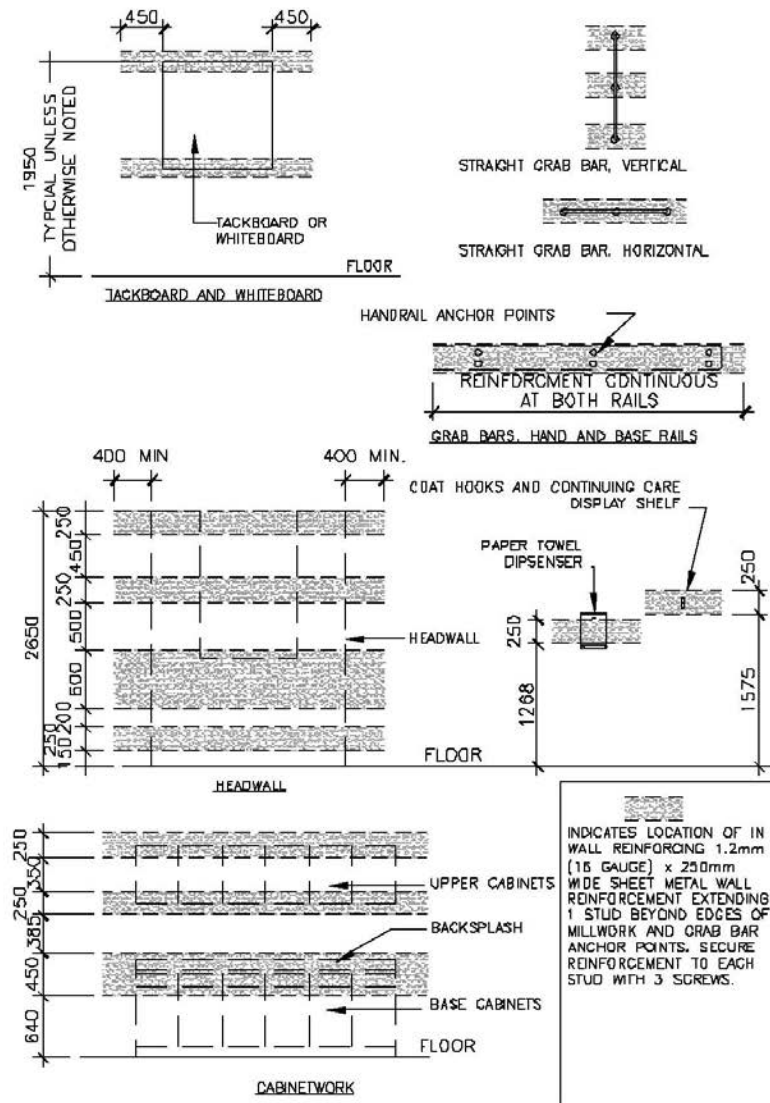
3.2 INSTALLATION

- .1 Install accessories at heights to meet barrier free compliance and in coordination with drawings. Confirm heights with Departmental Representative prior to installation.
- .2 Install and secure accessories rigidly in place as follows:
 - .1 Stud walls: install steel back-plate to stud prior to plaster or drywall finish. Provide plate with threaded studs or plugs.

- .2 Hollow masonry units or existing plaster/drywall: use toggle bolts drilled into cell/wall cavity.
- .3 Solid masonry, marble, stone or concrete: use bolt with lead expansion sleeve set into drilled hole.
- .4 Toilet/shower compartments: use male/female through bolts.
- .3 Install grab bars on built-in anchors provided by bar manufacturer.
- .4 Use tamper proof screws/bolts for fasteners.
- .5 Fill units with necessary supplies shortly before final acceptance of building.
- .6 Install mirrors in accordance with Section 08 80 50 - Glazing.

3.3 SCHEDULE

- .1 Locate accessories where indicated on drawings. Exact locations determined by Departmental Representative.



Wall Reinforcement Details

END OF SECTION

1. General

1.1. WORK INCLUDED

- .1 Conform to the requirements of Division 1, which applies to and forms part of all sections of the work.
- .2 The Specification is divided into Sections which are not intended to identify contractual limits between Sub-Contractors nor between the Contractor and his Sub-Contractors. The requirements of any one Section apply to all Sections. Refer to other Divisions and Sections to ensure a complete and operational system.
- .3 Provide mechanical components and accessories which may not be specifically shown on the Drawings or stipulated in the Specifications, but are required to ensure complete and operational systems.

1.2. INTENT

- .1 Mention in the Specifications or indication on the Drawings of equipment, materials, operation and methods, requires provision of the quality noted, the quantity required, and the systems complete in every respect.
- .2 The Specifications are an integral part of the accompanying Drawings. Any item or subject omitted from one or the other, but which is either mentioned or reasonably implied, shall be considered as properly and sufficiently specified.
- .3 Be completely responsible for the acceptable condition and operation of all systems, equipment and components forming part of the installation or directly associated with it. Promptly replace defective material, equipment and part of equipment and repair related damages.

1.3. SECTIONS AFFECTED

- .1 These instructions apply to and form a part of all Mechanical Sections.

1.4. REGULATIONS

- .1 Work shall be performed in accordance with codes, rules, regulations, by-laws and requirements of the authorities having jurisdiction.
- .2 The plumbing and drainage systems shall comply with regulations respecting plumbing made under the National Plumbing Code and Alberta Plumbing and Drainage Act except as modified by rules, regulations and by-laws of authorities having jurisdiction.
- .3 Natural gas systems shall be in accordance with the Gas Protection Act and Installation Code of Natural Gas Burning Appliances and Equipment Code CAN B-149.
- .4 These specifications are supplementary to the requirements above.
- .5 Drawings and specifications should not conflict with the above regulations but where there are apparent discrepancies the Contractor shall notify the Owner.

1.5. PERMITS, FEES INSPECTION

- .1 Obtain all permits, make submissions, pay all fees and arrange for all inspections required for the work of this Division.

1.6. EXAMINATION OF SITE

- .1 Before submitting Bids, each trade shall examine the site to determine the conditions which may affect the proposed work. No claims for extra payment will be considered because of failure to fulfil this condition.

1.7. DRAWINGS, CHANGES AND INSTALLATION

- .1 The Drawings shall be considered to show the general character and scope of the work and not the exact details of the installation. The installation shall be complete with all accessories required for a complete and operational installation.
- .2 The location, arrangement and connection of equipment and material as shown on the Drawings represents a close approximation to the intent and requirements of the work. The right is reserved by the Owner to make reasonable changes required to accommodate conditions arising during the progress of the work, at no extra cost to the Owner.
- .3 In order to show more clearly the arrangement of the work, plans and sections do not show every valve, thermometer, pressure gauge or other system accessory. Refer to the Mechanical Standard Details and to the Specifications to determine the requirements.
- .4 Certain Details indicated on the Drawings are general in nature and specific labelled detail references to each and every occurrence of use are not indicated, however, such details shall be applicable to every occurrence.
- .5 All piping and ductwork in finished areas shall be concealed in ceiling spaces and shafts or chased into walls. No exposed piping or ductwork shall be installed in such areas unless specifically reviewed and accepted by the Owner. No piping shall be concealed in outside walls.
- .6 Vent pipes, exhaust hoods or other mechanical equipment mounted on the roof, or housing for such equipment shall not be closer to the edge of the roof than a distance equal to the height of the pipe, hood or equipment, unless specifically reviewed and accepted by the Owner.
- .7 The location and size of existing services shown on the Drawings are based on the best available information. The actual location of existing services shall be verified in the field before work is commenced. Particular attention shall be paid to buried services.
- .8 Changes and modifications necessary to ensure co-ordination and to avoid interference and conflicts with other Trades, or to accommodate existing conditions, shall be made at no extra cost to the Owner.

- .9 Leave areas clear of piping and ducts where space is indicated as reserved for future equipment and equipment for other Trades.
- .10 Adequate space and provisions shall be left for removal of coils and servicing of equipment, with minimum inconvenience to the operation of systems.
- .11 Where equipment is shown to be 'roughed-in only' obtain accurate information from the Owner before proceeding with the work.
- .12 Before fabricating ductwork or piping for installation, make certain that such items can be installed as shown on the Drawings without interfering with the structure or the work of other Trades. Any problems that cannot be solved in agreement with the other Trades affected shall be submitted for decision. If ductwork or piping is prefabricated prior to the investigation and reaching of a solution to possible interference problems, necessary changes in such prefabricated items shall be made at no extra cost to the Owner.
- .13 Location of diffusers, grilles registers, thermostats and all other equipment shown on plans is diagrammatic. Layout of each device in finished areas is critical in terms of symmetry and location. Refer to Architectural Drawings and to site instructions in all regards. Any work not installed in the correct location (at the sole discretion of the Owner) shall be remedied by this Contractor at his expense. This Contractor is responsible for mark-out of his work, fully coordinated with all other trades, in sufficient time for review by Owner prior to rough-in. All mechanical services shall be located precisely.

1.8. INSTALLATION, INTERFERENCE AND SETTING DRAWINGS

- .1 Installation, interference and setting Drawings dimensioned and to scale, shall be submitted for review by the Owner, as may be required or requested by the Owner to make clear the work intended or to show its relation to adjacent work or to the work of other trades. When an alternative piece of equipment is to be substituted for equipment shown, Drawings of the area involved shall be prepared by this Division. Three copies of such Drawings shall be submitted for review, of which one will be retained by the Owner. Electronic copies in PDF format are also acceptable.
- .2 Installation working Drawings to 1:50 scale (1/4 in. equal to 1 ft.) for mechanical rooms showing plan and sections of the plant, services, bases, curbs, drains, motor terminals, shall be prepared by this Division.
- .3 Interference Drawings are required for shafts, ceiling spaces, typical floors and wherever there is possible conflict with the positioning of mechanical equipment, piping or ductwork and architectural or structural features or the work of other trades.
- .4 The design of the structural framing of the mechanical rooms and pipe spaces and major pipe run supports has been based on assumed loadings supplied during the design phase. Well ahead of the construction of the affected areas, prepare and submit Drawings for review by the Owner showing the layout and weights of all finally selected mechanical equipment including details of concrete pads, concentrated pipe loads and point reactions of the equipment onto the structure.

- .5 This Division shall prepare sleeving Drawings indicating the size and locations of openings required in concrete floor slabs, roof slabs/decks and walls for piping, ductwork and equipment. In case of failure to provide information in time (i.e. before the concrete is poured) any extras incurred shall be at the expense of this Division.
- .6 Work shall not proceed in areas involved until after final review of such Drawings has been obtained.

1.9. BID FORM AND SUBMISSIONS OF BIDS

- .1 Submit with the bid, all information called for on the Bid Form. Bids not completed in full may, at the discretion of the Owner may be rejected.
- .2 Show separate and unit prices for optional equipment or systems called for as additions to or deductions from the Bid amount.
- .3 Where only one name appears in the specification, the Bid shall include for the specified equipment.
- .4 Where two or more names are shown in the specifications as alternatives or equal to, this Division can select which manufacturer is to be carried, provided the choice is shown on the Mechanical Bid Form. Where the choice is not indicated, the equipment described in the specification or first named on the Mechanical Bid Form shall be supplied.
- .5 This Division is invited to list substitute equipment as a price deduction to the Bid price. Space has been provided to show manufacturers not specifically mentioned. Acceptance of substitute equipment shall be at the discretion of the Owner whose decision shall be final.
- .6 Materials and products specified by the name of the manufacturer, the brand or trade name, or catalogue reference, shall be the basis of the Bid price. These shall be provided under the Contract unless substitutions are proposed and accepted in accordance with the following procedures:
 - .1 Substitution may be proposed only when the clause or other approved manufacturer is used in the specification.
 - .2 The proposed substitution shall be listed under Substitute Equipment on the Mechanical Bid Form.
 - .3 The proposed substitution shall indicate product name, a complete product description and what difference, if any, will be made in the amount of the Bid price for the substitution.
- .7 Any alternative and/or substitute equipment listed shall be equal in performance and quality to that specified. If space, power, structural or any other requirements are different from the equipment specified, the cost of any changes shall be included for in the price shown on the Mechanical Bid Form.
- .8 The Owner reserves the right to accept or reject any substitution without question.

1.10. MATERIALS

- .1 Make and quality of materials used in the construction of this work shall be subject to

the approval of the Owner.

- .2 Materials and equipment supplied by this Division shall be new and free from defects and shall be as specified by the manufacturer's name and catalogue reference.
- .3 Where a certain manufacturer's equipment has been specified by name or model number, the Contractor shall be responsible for ensuring that the performance and quality of any proposed alternative meets the specified equipment and that the same access or maintenance space is available for the alternative manufacturer's equipment and that piping, duct and electrical connections can be made at no extra cost to the Contract.

1.11. CO-OPERATION WITH OTHER DIVISIONS

- .1 Particular attention must be paid to the proximity of electrical conduit and cable to mechanical piping and equipment.
- .2 Pipes transporting hot fluids shall be installed at least 150 mm (6 in.) away from pipes carrying cold fluids, unless approval from the Owner is obtained to install services closer than 150 mm (6 in.).
- .3 Electrical conduits shall not touch or be supported from piping or ductwork.
- .4 Each Section shall confine itself to installing all materials in the spaces shown without encroaching upon space for materials installed under other Sections or Divisions. Where the space allocated to another Section or Division is encroached upon, the materials shall be relocated to their proper space allocation in such a manner to complete the work using space allocated to the various Sections and Divisions. Relocation of materials and work involved shall be paid for by the Section responsible for the encroachment at no extra cost to the Owner.
- .5 Supply all items to be built in ample time for rapid progress of the work. Schedule and proceed with work as required to satisfy the construction schedule.
- .6 The Contractor shall confirm the available voltage for all single phase and three phase motors or other similar electrically driven equipment with the Electrical Division prior to ordering the equipment. Any discrepancy between the requirements identified within the Contract Documents and those of the Electrical Division shall be reported to the Owner and the equipment shall be adjusted to suit the appropriate power requirements. Failure to perform this coordination prior to ordering of the motors or equipment shall result in correction at no additional cost to the Owner.

1.12. TEMPORARY USE OF EQUIPMENT

- .1 Where the mechanical systems are operated during construction, the Mechanical Contractor shall maintain the system and equipment in proper operating condition.
- .2 Prior to application for substantial performance of the work as certified by the Owner, the systems and equipment shall be returned to the initial new condition by replacing used air filters with new air filters, cleaning the air side of all coils in the air handling systems, replacing used belts in belt drives with new belts, lubricating all bearings according to manufacturer's factory standards and adjusting the thermostatic control system according

to specifications and/or to suit the Owner.

1.13. INTERRUPTION OF SERVICES

- .1 Any interruption of the mechanical services to any part of the building shall come at a time agreeable to the Owner. Make all necessary arrangements with those concerned and include for any overtime required to ensure that the interruption is held to a minimum.
- .2 Testing and operation of major equipment shall be approved by the Owner to avoid excessive utility charges. Such testing to be generally carried out after normal working hours or on weekends.
- .3 All such overtime work shall be carried out without additional cost to the Contract.

1.14. STATEMENT OF PRICES

- .1 For the purpose of progress applications the Contractor shall submit a statement of his estimated prices for the various portions of the work, including labour, materials and equipment shown separately. The total price of all portions of the work shall equal the total price of the work covered under the Mechanical Division.
- .2 The Contractor shall submit the breakdown of work for this Contract to the Owner for review and approval. The breakdown shall be in sufficient detail to enable the Owner to evaluate the progress of work and shall identify all major equipment, components and sub trades.

1.15. METRIC CONVERSIONS

- .1 Particular care shall be taken with imperial versus S.I. metric conversions. This applies to all services including, but not limited to, equipment, pipes, ductwork and site services in both new and existing installations.
- .2 Conform to the Canadian Metric Practice Guide CSA-CAN3-2234-1-89.

1.16. ALTERNATIVE, SEPARATE AND IDENTIFIED PRICES

- .1 Several alternative, separate and identified prices have been requested. These shall be completed on the Mechanical Bid Form. Prices not on the Mechanical Bid Form will not be accepted after the fact. Refer to the specific Sections of the Specifications and to the Drawings for details.

1.17. SCHEDULE, ACCESS, PROTECTION AND CLEAN-UP

- .1 The construction schedule places restrictions on the duration of construction within areas and the duration of shut-down of equipment. Refer to the General Conditions for all requirements.
- .2 Access to the site is limited to location and time of day. Access to areas of the building is limited to location and time of day. Refer to the General Conditions and conform to all

requirements.

- .3 Refer to the security and protection requirements in the General Conditions and conform to all requirements. In particular no open flames shall be used without prior written approval of the Owner. There shall be no smoking, and the site shall be kept clean at all times.

1.18. HOUSEKEEPING PADS, CURBS AND SUPPORT PIERS

- .1 Provide concrete housekeeping pads, curbs and support piers under all floor mounted mechanical equipment and around all floor penetrations for pipes and ducts. Housekeeping pads and curbs shall be minimum 100 mm (4 in.) high unless detailed otherwise. Refer to the Drawings and Details for additional information.
- .2 Housekeeping pads, curbs and support piers under all floor mounted mechanical equipment and around all floor penetrations for pipes and ducts shall be provided by Division 3. This Division shall coordinate all sizes and locations for housekeeping pads and curbs. Provide dimensioned drawings for review by the Owner. All housekeeping pads shall be minimum 100 mm (4 in.) high unless detailed otherwise. Refer to the Drawings and Details for additional information.

1.19. ASHRAE 90.1

- .1 All mechanical equipment shall comply with the minimum efficiency standards set out in ASHRAE 90.1 and the Model National Energy Code of Canada for Buildings. Submit all necessary information to substantiate conformance.

1.20. HOISTING FACILITIES

- .1 This Division shall provide its own hoisting facilities.
- .2 Hoisting facilities provided by General Contractor will be available for Subcontractors use at no cost. If hoist facilities are inadequate then Sub-Contractors must provide his own. Sub- Contractors must inform General Contractors of requirements before tender closing date.

2. Products

2.1. NOT USED

3. Execution

3.1. NOT USED

END OF SECTION

1. General

1.1. ABBREVIATIONS

.1 Generally, the following abbreviations are used in this Division:

A.A.B.C.	-	Associated Air Balance Council
AAP	-	Alarm Annunciator Panel
A.B.M.A.	-	American Boiler Manufacturers Association
ACO	-	Acid Resistant Cleanout
AD	-	Acid Resistant Drawings
AFD	-	Acid Resistant Floor Drain
AFF	-	Above Finished Floor
A.G.A.	-	American Gas Association
A.M.C.A.	-	Air Moving and Conditioning Association
A.N.S.I.	-	American National Standards Institute
A.R.I.	-	Air-Conditioning and Refrigeration Institute
A.S.H.R.A.E.	-	American Society of Heating, Refrigerating and Air Conditioning Engineers
A.S.M.E.	-	American Society of Mechanical Engineers
A.S.T.M.	-	American Society for Testing and Materials
AV	-	Acid Resistant Vent
A.W.G.	-	American Wire Gauge
AWS	-	American Welding Society
A.W.W.A.	-	American Water Works Association
B.H.P.	-	Boiler Horsepower or Brake Horsepower
Btu/hr	-	British Thermal Units per Hour
B.W.G.	-	British Wire Gauge
CAD	-	Computer Aided Drafting
CAV	-	Controllable Air Flow Venturis
CAP	-	College of American Pathologists
CCA	-	Chromated Copper Arsenate
C.E.M.A.	-	Canadian Electrical Manufacturer's Association
CEMS	-	Central Energy Management System
CCF	-	Central Computer Facility
cfm	-	Cubic Feet per Minute
C.G.A.	-	Canadian Gas Association
C.G.S.B.	-	Canadian General Standards Board
C.I.	-	Cast Iron
CPU	-	Central Processing Unit
C.R.N.	-	Canadian Registration Number
CSA	-	Canadian Standards Association
cu.ft.	-	Cubic Feet
cu.m.	-	Cubic Meter
db	-	Dry Bulb
dB	-	Decibel
dBA	-	A-weighted Decibel
DDC	-	Direct Digital Control
deg. C	-	Degrees Celsius
deg. F.	-	Degree Fahrenheit

dia.	-	Diameter
DPDT	-	Double Pull Double Throw
DPTX	-	Differential Pressure Transmitters
EAP	-	Excess Exhaust Alarm Panel
E.D.R.	-	Equivalent Direct Radiation
EF	-	Exhaust Fan
E.E.M.A.C.	-	Electrical and Electronic Manufacturers Association of Canada
EEPROM	-	Electrically Erasable Programmable Read-Only Memory
EMT	-	Electrical Metallic Tubing
EP	-	Electric Pneumatic
EPDM	-	Ethylene Propylene Diene-Rubber
EPROM	-	Electrically Programmable Read Only Memory
ERW	-	Electric Resistance Welded
FACP	-	Fire Alarm Control Panel
FDA	-	Food and Drug Administration
F.E.	-	Flexible Elastomeric
FHC	-	Fume Hood Controller or Firehose Cabinet
F.L.A.	-	Full Load Amps
fpm	-	Feet per Minute
fps	-	Feet per Second
F.M.	-	Factory Mutual
ft.	-	Foot or Feet
ga	-	Gauge
gal	-	Gallons
GFD	-	Gallons per Square Feet per Day
G.P.D	-	Gallons per Day
G.P.H.	-	Gallons per Hour
GSS	-	Galvanized Sheet Steel
h-cu.ft.	-	Hour-cubic foot
HCFC	-	HydroChloroFlourocarbons
HEPA	-	High Efficiency Particulate Air
H.O.A.	-	Hand/Off/Auto
HOT	-	Hand Held Operator Terminal
H.S.S.	-	Hollow Steel Sections
HTK	-	Hood Termination Kit
hp	-	High Pressure or Motor Horsepower
hz	-	Hertz
I.A.O.	-	Insurance Advisory Organization of Canada
I.C.U.	-	Intensive Care Unit
(I.)G.P.H.	-	(Imperial) Gallons per Hour
(I.)G.P.M.	-	(Imperial) Gallons per Minute
in.	-	Inch or Inches
kg	-	Kilogram
kg/cu.m.	-	Kilogram per cubic meter
kPa	-	Kilopascals
KVA	-	Kilovolt-amps
kW	-	Kilowatts
lbs/cu.ft.	-	Pounds per cubic foot
lbs/hr.	-	Pounds per Hour
L	-	Litre
L/s	-	Litres per Second
LFC	-	Laminar Flow Cabinets

LEDs	-	Light Emitting Diode
LCP	-	Laboratory Control Panel
lin.ft.	-	Linear foot
lin.m.	-	Linear meter
ma	-	Milliamps
MAC	-	Make-up Air Controller
mADC	-	Milliamps Direct Circuit
M.B.H.	-	1000 British Thermal Units per Hour
M.C.C.	-	Motor Control Centre
mm	-	Millimetre
m	-	Metre
m/s	-	Metres per Second
mL	-	Millilitre
MCP	-	Motor Control Panel
M.O.V.	-	Motor Over Voltage
mPa	-	Millipascals
MSC	-	Master Summing Controller
MSG	-	Manufacturers' Standard Gauge
N.B.S.	-	National Bureau of Standards
N.C.	-	Noise Criterion as Defined by Graph in A.S.H.R.A.E.
NCCLS	-	National Committee for Clinical Laboratory Standard
N.E.M.A.	-	National Electrical Manufacturer's Association
N.F.P.A.	-	National Fire Protection Association
NIM	-	Network Interface Module
NIST	-	National Institute of Standards and Technology
NIOSH	-	National Institute of Occupational Safety and Health
NPS	-	American National Standard Straight Pipe Thread
N.P.S.H.	-	Net Positive Suction Head
NPT	-	American National Standard Taper Pipe Thread
No.	-	Number
OAT	-	Outside Air Temperature
O.B.C.	-	Ontario Building Code
OC	-	On Centre
OCP	-	Operator Control Panel
OPSS	-	Ontario Provincial Standard Specification
O.S. & Y.	-	Outside Screw and Yoke
O.W.R.A.	-	Ontario Water Resources Act
oz.	-	Ounce or Ounces
PCU	-	Personal Computer Unit
PE	-	Pneumatic Electric
PIT	-	Portable Interface Terminal
ph	-	Hydrogen Ion Concentration
ppm	-	Part per Million
psf	-	Pounds per Square Foot
psi	-	Pounds per Square Inch
psia	-	Pounds per Square Inch Absolute
psig	-	Pounds per Square Inch Gauge
PWM	-	Pulse Width Modulation
PVC	-	Polyvinyl Chloride
qt.	-	Quart
RAH	-	Return Air Humidity
Rh	-	Relative Humidity

rpm	- Revolutions perMinute
RPU	- Remote Processing Unit
RPU-TU	- Remote Processing Unit for Terminal Units
SCR	- Silicone Controlled Rectifier
SMACNA	- Sheet Metal and Air Conditioning Contractors National
sp. in. wg.	- Static Pressure, Inches Water Gauge
S.P.D.T.	- Single Pull Double Throw
SPS	- Sash Position Sensor
s.s	- Stainless Steel
SF	- Supply Fan
SPS	- Sash Position Sensor
SPWM	- Sine-Coded Pulse Width Modulated
S.S.P.C.	- Steel Structures Painting Council (The Society of Protective
sq.m.	- Square Meter
STC	- Supply/Exhaust Tracking Controller
SWS	- Sidewall Velocity Sensors
T.D.S.	- Totally Dissolved Solids
TEFC	- Totally Enclosed Fan Cooled
TIG	- Tungsten Inert Gas
TKV-TWA	- Threshold Limit Value – Time Weighted Average
UACU	- Unitary Air Conditioning Units
U.L.	- Underwriter's Laboratories
U.L.C.	- Underwriter's Laboratories of Canada
um	- Ohm
USP	- United States Pharmacopoeial
U.S. gal.	- United States Gallons
USGPH	- United States Gallons per Hour
USGPM	- United States Gallons per Minute
VAC	- Volts Alternating Current
VACFH	- Closed Loop Variable Frequency Drive
VDC	- Volts Direct Current
VFD	- Variable Frequency Drive
VSC	- Variable Speed Controllers
VSD	- Variable Speed Drives
W	- Watt
W/cu.m.	- Watts per Cubic Meter
W/ft.	- Watts per Foot
W/m	- Watts per Meter
W/sq.in.	- Watts per Square Inch
W/sq.m.	- Watts per Square Meter
WC	- Water Closet
wb	- Wet Bulb
wg	- Water Gauge
WHMIS	- Workplace Hazardous Material Information System
WSP	- Working Steam Pressure
WOG	- Water, Oil, Gas

END OF SECTION

1. General

1.1. WORK INCLUDED

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. RELATED WORK SPECIFIED ELSEWHERE

- .1 Refer to Record Drawings in Section 01 70 00.00 (01 72 29.00) – CLOSEOUT SUBMITTALS.

1.3. PRINTS

- .1 The Owner will provide the Mechanical Contractor with two sets of white prints to mark the project progress, changes and deviations.

2. Products

1.4. NOT USED

2. Execution

2.1. DOCUMENTATION REQUIREMENTS

- .1 As the project progresses mark all changes and deviations from that shown on the drawings to the white prints.
- .2 After inspection and approval of service lines in trenches, take as-built measurements, including all depths, prior to commencement of backfilling operations. It will not be sufficient to check off line locations. Take and record definitive measurements for each service line. Show locations and inverts of buried piping on the drawings and dimensioned from grid co-ordinates.
- .3 Photograph all buried underground services prior to backfilling. Mark on prints photograph numbers.
- .4 Keep drawings up-to-date during construction and in addition to field measurements include change orders, site instructions and all other changes. Drawings shall be available for review at all times.

- .5 On completion of the work, forward to the Owner the two sets of drawings indicating all such changes and deviations for review by the Owner.
- .6 The project will remain incomplete and a holdback will be retained until satisfactory as-built drawings are provided.
- .7 Include a cost of \$1,200.00 for the transfer of marked up below grade 'As Built' information to AutoCAD and forwarding of the mechanical information by the owner to the owner.
- .8 Cost to be determined for the transfer of marked up above grade 'As Built' information to AutoCAD and forwarding of the mechanical information by the owner to the owner.

END OF SECTION

1. General

1.1. WORK INCLUDED

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. RELATED WORK SPECIFIED ELSEWHERE

- .1 Refer to Record Drawings in Section 01 70 00.00 (01 72 29.00) – CLOSEOUT SUBMITTALS.

1.3. PRINTS

- .1 The Owner will provide the Mechanical Contractor with two sets of white prints to mark the project progress, changes and deviations.

2. Products

1.4. NOT USED

2. Execution

2.1. DOCUMENTATION REQUIREMENTS

- .1 As the project progresses mark all changes and deviations from that shown on the drawings to the white prints.
- .2 After inspection and approval of service lines in trenches, take as-built measurements, including all depths, prior to commencement of backfilling operations. It will not be sufficient to check off line locations. Take and record definitive measurements for each service line. Show locations and inverts of buried piping on the drawings and dimensioned from grid co-ordinates.
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- .7 Include a cost of \$1,200.00 for the transfer of marked up below grade 'As Built' information to AutoCAD and forwarding of the mechanical information by the owner to the owner.
- .8 Cost to be determined for the transfer of marked up above grade 'As Built' information to AutoCAD and forwarding of the mechanical information by the owner to the owner.

END OF SECTION

1 GENERAL

1.1 GENERAL

- 1.1.1 This section covers items common to all sections of Mechanical Divisions (Divisions 21, 23 and 25).

1.2 ADMINISTRATIVE

- 1.2.1 Submit to Owner submittals, generally consisting of shop drawings or product data, listed for review. Submit with reasonable promptness and in an orderly sequence so as to not cause delay in the work. Failure to submit in ample time is not considered sufficient reason for an extension of contract time and no claim for extension by reason of such default will be allowed.
- 1.2.2 Submittals which do not comply with the requirements herein will be returned without review by Owner.
- 1.2.3 Each copy of all submittals shall be covered by a title sheet prepared by the submitting contractor. The title sheet MUST include the following:
- 1.2.3.1 Name of project.
 - 1.2.3.2 Project number (15-5342)
 - 1.2.3.3 Title of Submittal.
 - 1.2.3.4 Number of Submittal.
 - 1.2.3.5 Number of pages under title page.
 - 1.2.3.6 Description of contents of Submittal (including Equipment Tag indicated on drawings).
 - 1.2.3.7 Specification section number relating to Submittal.
 - 1.2.3.8 Name and phone number of person who may be contacted by Owner in case of need for technical clarification on Submittal contents.
 - 1.2.3.9 Name and phone number of contractor's representative who may be contacted by the Owner for information on Submittal contents.
 - 1.2.3.10 Stamp (dated and signed) attesting that submittal has been reviewed by contractor.
 - 1.2.3.11 BLANK area no smaller than 200 mm wide x 125 mm high for exclusive use by Owner for stamps and review comments.
- 1.2.4 Work affected by the submittal shall not proceed until review is complete.

- 1.2.5 Comments or corrections made on the submittals during this review by the Owner do not relieve the contractor from compliance with the requirements of the drawings and specifications. This review is for the general conformance with the design concept of the project and general compliance with the information given in the contract documents. The contractor is responsible for confirming and correlating all quantities and dimensions; selecting fabrication processes and techniques of construction; co-ordinating his or her work with that of other trades and performing all work in a safe and satisfactory manner.
- 1.2.6 Review submittals prior to submission to the Owner. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and co-ordinated with the requirements of the work and the contract documents.
- 1.2.7 Contractor's responsibility for errors and omissions in submission is not relieved by Owner's review of submittals.
- 1.2.8 Keep one reviewed copy of each Submittal on site.
- 1.3 SHOP DRAWINGS AND PRODUCT DATA
 - 1.3.1 Submit shop drawings and product data in accordance with Division 01 and as specified in this section.
 - 1.3.2 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by the Contractor to illustrate details of a portion of the Work.
 - 1.3.3 Adjustments made on shop drawings by the Owner is not intended to change the contract price. If adjustments affect the value of work, state such in writing to the Owner prior to proceeding with the work.
 - 1.3.4 Make changes in shop drawings as the Owner may require, consistent with contract documents. When resubmitting, notify the Owner in writing of any revisions other than those requested.
 - 1.3.5 Submit twelve (12) copies of shop drawings and/or product data for each requirement requested in specification sections and as the Owner may reasonably request.
 - 1.3.6 If upon review by the Owner no errors or omissions are discovered or if only minor corrections are made prints will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through the same procedure indicated above, shall be performed before fabrication and installation of work may proceed.
 - 1.3.7 Shop drawings and product data shall show:

- 1.3.7.1 Mounting arrangements.
- 1.3.7.2 Operating and maintenance clearances. eg. access door swing spaces.
- 1.3.7.3 Materials of construction.
- 1.3.7.4 Identify, type, size, and location for piping ductwork, electrical and control connections.

1.3.8 Shop drawings and product data shall be accompanied by:

- 1.3.8.1 Detailed drawings of bases, supports, and anchor bolts.
- 1.3.8.2 Acoustical sound power data, where applicable.
- 1.3.8.3 Points of operation on performance curves.
- 1.3.8.4 Manufacturer to certify as to current model production.
- 1.3.8.5 Certification of compliance to applicable codes.

1.4 OPERATING MAINTENANCE MANUALS

- 1.4.1 Submit to the Owner sixty (60) days prior to substantial performance of the work, one copy of the operating and maintenance manual for review. Make all corrections as indicated by the review and thirty (30) days prior to substantial performance submit three copies of the completed manuals to the Owner. Substantial completion may be withheld for non-compliance.
- 1.4.2 Instructions in this manual shall be in simple language so as to guide the Owner in the proper operation and maintenance of mechanical components.
- 1.4.3 Operation data to include:
 - 1.4.3.1 Complete schematic drawings for each control system.
 - 1.4.3.2 Description of each system and its control.
 - 1.4.3.3 Description of operation of each system at various loads together with reset schedules and seasonal variances.
 - 1.4.3.4 Operation instructions for each system and each component.
 - 1.4.3.5 Description of actions to be taken in the event of equipment failure.
 - 1.4.3.6 Valve schedule number location and service, and flow diagrams.
 - 1.4.3.7 Color coding charts.
- 1.4.4 Maintenance data shall include:
 - 1.4.4.1 Servicing, maintenance, lubrication, operation and trouble shooting instructions for each item of equipment.
 - 1.4.4.2 Data to include schedules of tasks, frequency, eg. Daily (D), Weekly (W), Monthly (M), Semi-annually (SA), Annually (A), and special tools required.
- 1.4.5 Performance data to include:

- 1.4.5.1 Equipment manufacturer's performance data with point of operation as left after commissioning is complete.
- 1.4.5.2 Copy of all approved shop drawings.
- 1.4.5.3 Equipment performance verification test results.
- 1.4.5.4 Testing, adjusting and balancing reports specified in Section 23 05 93- Testing, Adjusting and Balancing.
- 1.4.5.5 Test reports as required in other sections:
 - 1.4.5.5.1 Plumbing test reports.
 - 1.4.5.5.2 Gas fired equipment test reports.
 - 1.4.5.5.3 Pressure test reports for all piping systems.
 - 1.4.5.5.4 Hydronic systems cleaning and treatment reports.
 - 1.4.5.5.5 Fire protection systems tests and reports.
 - 1.4.5.5.6 Chemical treatment reports.
- 1.4.5.6 Additional data:
 - 1.4.5.6.1 .1 Prepare and insert additional data into the operation and maintenance manual when the need becomes apparent during demonstrations and instructions specified above.
- 1.4.5.7 Bind contents in aexpanding spine, hard covered, green cloth covered binder. Binder covers to be attached to spine with piano hinges. Identify binder by hot stamping front and spine of binder, with the name of the Project, name of the Owner, name of the Architect, name of the Owner. Submit copy of binder identification for review prior to ordering binder. Organize contents into applicable categories of work, parallel to specifications sections.
- 1.4.5.8 Information specified: Tabulate into divisions using divider stabbed with colored mylar plastic tabs identified and numbered as follows:
 - 1.4.5.8.1 Division 1. General. (Clear)
 - 1.4.5.8.2 Division 2 Plumbing. (Green)
 - 1.4.5.8.3 Division 3. Fire Protection Systems. (Red)
 - 1.4.5.8.4 Division 4. Heating. (Yellow)
 - 1.4.5.8.5 Division 5. Ventilation and Air Conditioning. (Blue)
 - 1.4.5.8.6 Division 6. Controls. (Orange)
- 1.4.5.9 Division One
 - 1.4.5.9.1 Tab 1.0: Title of Project with clear plastic cover.
 - 1.4.5.9.2 Tab 1.1: Index
 - 1.4.5.9.3 Tab 1.2: Mechanical Drawings: List of Mechanical Drawings.
 - 1.4.5.9.4 Tab 1.3: Name, Address, and Telephone number of Architect, Owner and Contractors.
 - 1.4.5.9.5 Tab 1.4: List of all Equipment Suppliers, Name, Address, Phone number, Fax number, and Contact person, as well Procedures for purchasing parts and equipment.

1.4.5.9.6 Tab 1.5: Mechanical Systems Overview: Provide a detailed description of mechanical systems including operating sequence for each and all systems. Describe individual components and how they interface with each other and the total system. Identify locations of thermostats, control devices and switches, summer and winter operating variances, and control operating set points.

1.4.5.9.7 Tab 1.6: Warranties, Guaranties and Test Certificate.

- Written guarantee for mechanical systems.
- Manufacturers guarantees, and warranties for equipment.
- Test reports in accordance with Section 23 01 10
- Manufacturers start up and certification reports as specified in individual Sections.
- Fire protection systems tests and certification.

1.4.5.10 DivisionTwo/Three/Four/Five/Six

1.4.5.10.1 Tab 2.1, 3.1, 4.1, 5.1: Performance data.

1.4.5.10.2 Tab 2.2, 3.2, 4.2, 5.2: Maintenance data.

1.4.5.10.3 Tab 2.3, 3.3, 4.3, 5.3: Operation data.

1.4.5.10.4 Tab 6.1 Controls: Detailed Systems description.

1.4.5.10.5 Tab 6.2 Controls: Performance data.

1.4.5.10.6 Tab 6.3 Controls: Maintenance data.

1.4.5.10.7 Tab 6.4 Controls: Operation data.

1.5 RECORD (AS-BUILT) DRAWINGS

- 1.5.1 Obtain an extra set of white prints and as the work progresses, clearly and accurately record on this set of prints, in red ink, all conduit runs, wire counts and equipment locations as actually installed. Submit record drawings to the Owner within thirty(30) days of the date of acceptance of the project.
- 1.5.2 Record drawings shall be kept current on a day to day basis and shall be kept in the Contractor's field office and shall be accessible to the Owner's representative at all times.
- 1.5.3 The Owner shall update the CAD database as per the record drawings submitted. The Owner will provide reproducible record drawings and submit to the Owner for their records.

1.6 CERTIFICATES AND TRANSCRIPTS

- 1.6.1 Immediately after award of contract, submit Workers' Compensation Board status and transcription of insurances.

END OF SECTION

1 GENERAL

1.1 GENERAL

- 1.1.1 This section covers items common to all sections of Mechanical Divisions (Divisions 21, 23 and 25).

1.2 WITNESSING OF TESTS

- 1.2.1 The Owner may witness selected starting, testing, adjusting, balancing and cleaning procedures.
- 1.2.2 Advise the Owner in advance that starting, testing, adjusting, balancing or cleaning processes are ready to commence. Consult with the Owner to determine which procedures he may elect to witness. Provide advanced notice prior to commencement of each procedure or series of procedures to allow the owner to arrange for witnessing of tests.

1.3 STARTING AND TESTING COSTS

- 1.3.1 Pay costs associated with starting, testing, adjusting, preparation for balancing and cleaning, including supply of instruments, equipment, supplies, and consumable materials.

1.4 START-UP REPORTS

- 1.4.1 Contractor shall provide start up reports for all equipment.
- 1.4.2 All start up reports must be completed and signed off by the contractors and manufacturers representative's.
- 1.4.3 The contractor is responsible for completing the check sheets as follows and as indicated on the attached sample:

Technical Data

Specified Data
Shop Drawing
Installed Verified
Date/Checked
by:

Owner
Contractor
Contractor
Owner
Contractor to sign when
shop drawing and
installed information is
completed.

Signatures:

Contractor to sign when the
check sheet is completed

Static Checks

Date/Checked by:

Contractor to sign when the items listed and installation of the equipment or systems are complete and ready for the owner to verify.

Signatures:

Contractor and Owner to sign when the check sheet is completed.

1.5 REPORTS

- 1.5.1 Submit Contractor Start-Up Report forms in accordance with Mechanical Equipment/System Startup and Testing documenting starting and testing procedures performed, and observed tests results obtained.
- 1.5.2 Submit field reports in accordance with Mechanical Equipment/System Startup and Testing.

1.6 QUALITY ASSURANCE

- 1.6.1 Use personnel for starting, equipment and starting procedures who have experience in mechanical equipment and systems commissioning, and are able to interpret results of readings and tests and report state of systems in a clear and concise manner.

1.7 MANUFACTURER'S RECOMMENDATIONS

- 1.7.1 Prior to starting equipment or systems, obtain and review manufacturer's installation, starting and operating instructions. Read in conjunction with procedures specified herein.
- 1.7.2 Use manufacturer's and supplier's trained personnel where necessary to maintain validity of manufacturer's warranty.
- 1.7.3 Compare actual installation with manufacturer's recommended installation. Record discrepancies. Correct deviations detrimental to equipment performance prior to starting equipment.

1.8 REGULATORY REQUIREMENTS

- 1.8.1 To facilitate expedient turnover of facility at Interim Acceptance of the Work, arrange for regulatory authorities to witness those specified starting procedures that duplicate tests required by regulatory authorities.
- 1.8.2 Obtain certificates of approval and for compliance with regulations from authorities having jurisdiction. Include copies of certificates with start-up reports.

2 PRODUCTS

- 2.1 NOT USED.

3 EXECUTION

3.1 INSPECTION

- 3.1.1 Do not conceal or cover equipment or systems until inspected, tested and approved by Owner.

3.2 CHECK SHEETS, FIELD REPORTS AND DATA

- 3.2.1 Record all data gathered on site on start-up report forms.
- 3.2.2 Make copies of all starting and testing data before equipment and system start-up personnel leave site. Maintain one copy of all data taken during starting on site.
- 3.2.3 Maintain one copy of all final starting, testing, adjusting and balancing reports on site up to Substantial Completion of the Work for reference purposes.

3.3 COORDINATION

- 3.3.1 Prior to commencement of each particular testing procedure, coordinate all sub-trades, manufacturers, suppliers and other specialties to ensure all phases of work are properly completed. Establish necessary manpower requirements.

3.4 STARTING AND TESTING PHASES

- 3.4.1 Starting and testing program generally consists of following five distinct phases:
- 3.4.1.1 Pre-Starting: visual inspection
 - 3.4.1.2 Starting: actual starting procedure.
 - 3.4.1.3 Post-Starting: operational testing, adjusting or balancing and equipment run-in phase.
 - 3.4.1.4 Substantial Completion of the Work: final cleaning, re-testing, and adjusting and maintenance.
 - 3.4.1.5 Final Acceptance of the Work: re-testing and fine-tuning of system to prove all deficiencies have been corrected.

- 3.4.2 After each distinct phase of work has been completed, correct deficiencies before commencing the next phase.

END OF SECTION

1 GENERAL

1.1 SUMMARY

1.1.1 Section Includes:

- 1.1.1.1 Electrical motors, drives and guards for mechanical equipment and systems.
- 1.1.1.2 Supplier and installer responsibility indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.
- 1.1.1.3 Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections below 50 V which are related to control systems specified in Division 22 and 23. Refer to Division 26 for quality of materials and workmanship.
- 1.1.1.4 Sustainable requirements for construction and verification.

1.2 REFERENCES

- 1.2.1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - 1.2.1.1 ASHRAE 90.1-01, Energy Standard for Buildings except Low-Rise Residential Buildings (IESNA cosponsored; ANSI approved; Continuous Maintenance Standard).
- 1.2.2 Electrical Equipment Manufacturers' Association Council (EEMAC)
- 1.2.3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - 1.2.3.1 Material Safety Data Sheets (MSDS).

1.3 QUALITY ASSURANCE

- 1.3.1 Regulatory Requirements: work to be performed in compliance with applicable Provincial/Territorial regulations.
- 1.3.2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

- 1.4.1 Packing, shipping, handling and unloading:
 - 1.4.1.1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
 - 1.4.1.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

1.4.2 Waste Management and Disposal:

- 1.4.2.1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse or recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

2 PRODUCTS

2.1 GENERAL

- 2.1.1 Motors: Premium efficiency, in accordance with local Hydro company standards and to ASHRAE 90.1.

2.2 MOTORS

- 2.2.1 Provide motors for mechanical equipment as specified.
- 2.2.2 Motors under 1/2 HP : speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.
- 2.2.3 Motors 1/2 HP and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40°C, 3 phase, 208V, unless otherwise indicated.

2.3 TEMPORARY MOTORS

- 2.3.1 If delivery of specified motor will delay completion or commissioning work, install motor for temporary use. Work will only be accepted when specified motor is installed.

2.4 BELT DRIVES

- 2.4.1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.
- 2.4.2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise indicated.
- 2.4.3 For motors under 7.5 kW 10 HP: standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.
- 2.4.4 For motors 7.5 kW 10 HP and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.
- 2.4.5 Correct size of sheave determined during commissioning.
- 2.4.6 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.

2.4.7 Motor slide rail adjustment plates to allow for centre line adjustment.

2.4.8 Supply one set of spare belts for each set installed in accordance with Section 01 78 00- Closeout Submittals.

2.5 DRIVE GUARDS

2.5.1 Provide guards for unprotected drives.

2.5.2 Guards for belt drives;

2.5.2.1 Expanded metal screen welded to steel frame.

2.5.2.2 Minimum 1.2 mm thick sheet metal tops and bottoms.

2.5.2.3 38 mm dia holes on both shaft centres for insertion of tachometer.

2.5.2.4 Removable for servicing.

2.5.3 Provide means to permit lubrication and use of test instruments with guards in place.

2.5.4 Install belt guards to allow movement of motors for adjusting belt tension.

2.5.4.1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.

2.5.4.2 Securely fasten in place.

2.5.4.3 Removable for servicing.

2.5.5 Unprotected fan inlets or outlets:

2.5.5.1 Wire or expanded metal screen, galvanized, 19 mm mesh.

2.5.5.2 Net free area of guard: not less than 80% of fan openings.

2.5.5.3 Securely fasten in place.

2.5.5.4 Removable for servicing.

3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

3.1.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

3.2.1 Fasten securely in place.

3.2.2 Make removable for servicing, easily returned into, and positively in position.

END OF SECTION

1 General

1.1 WORK INCLUDED

- 1.1.1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.1.2 All power and control wiring from starters, fused and non-fused switches, whether mounted in M.C.C.'s or individually, to all mechanical devices and equipment shall be provided by this Division except where shown and specified under the Electrical Division.
- 1.1.3 All starters for devices supplied by this Division shall be provided by this Division except where shown and specified under the Electrical Division.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- 1.2.1 All power wiring and starters for devices supplied by this Division shall be provided by the Electrical Division except where shown and specified under this Division. All control wiring shall be provided by this Division.
- 1.2.2 SUBMITTALS
- 1.2.3 Further to requirements of Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS, submit Shop Drawings of following:
 - 1.2.3.1 Submit an overload thermal element list with all supporting data for review prior to installation of the elements.
 - 1.2.3.2 Submit samples of nameplates for review before manufacturing.

2 Products

2.1 DISCONNECT SWITCHES

- 2.1.1 Disconnect safety switches shall either be fusible or non-fusible safety switches and shall be heavy duty type A with quick-make, quick-break contacts, and shall be horsepower rated to match motor protected. Manufacturer shall be Canadian Westinghouse, Schneider, Klockner Moeller, Cutler Hammer or Siemens. Provide hole for padlock in off position.
- 2.1.2 Fuse clips shall be supplied with non-renewable type fuses suitably rated to motor nameplate current for proper short circuit protection. All fuse holders shall be suitable for HRC Class J time delay fuses. Supply three (3) additional sets of spare fuses for each size of fuse used.
- 2.1.3 Utilize switches of one manufacturer throughout the building.

2.2 MOTOR CONTROL CENTRES

- 2.2.1 All motor control centres shall be free standing E.E.,M.A.C.1 Class II, Type B construction in all areas without sprinklers and shall be E.E.M.A.C.-2 drip-proof in all areas with sprinklers as manufactured by Allen Bradley, Siemens, Klockner Moeller, Schneider, Cutler Hammer.
- 2.2.2 All buswork shall be fully insulated and shall be copper, braced to withstand 40,000 AMP short circuit symmetrical.
- 2.2.3 No more than 7 NEMA size 1 or smaller combination of standard starters shall be installed in one section. Leave space for a fire alarm shutdown relay compartment as required.
- 2.2.4 All starters shall be complete with control transformer, pilot lights, and two normally open, normally closed auxiliary contacts. Separate pilot lights shall be used to indicate ON, OFF, LOW SPEED, and/or HIGH SPEED. Selector switches and pilot lights shall be heavy duty type. Provide high/low speed test positions in the hand mode for multi-speed motors. Starters smaller than size 1 shall not be used.
- 2.2.5 Provide elementary wiring diagrams to Class 2B standards to indicate the control scheme. A separate elementary wiring diagram shall be provided for each fan or pump and the following shall be indicated in each wiring diagram:
 - 2.2.5.1 Breaker size Motor hp Motor F.L.A.
 - 2.2.5.2 Control transformer KVA Overload size
 - 2.2.5.3 Interlock scheme Remote connection, etc. Thermistors
- 2.2.6 In each starter identify each wire and terminal with permanent number markings identical to the wiring diagrams.
- 2.2.7 The latching relay, pilot light and the alarm contact shall be housed as part of the starter in the motor control starter.
- 2.2.8 Size the overload thermal elements to the motor nameplate data and to the test curves (time/current/torque).
- 2.2.9 Overload relays, thermistor relays, heater elements and other devices shall be sized to fully protect the motor for all starting and locked rotor conditions with the overloads remaining active in the circuit at all times.
- 2.2.10 All three phase starters shall have 3 phase overload relays.
- 2.2.11 All starters shall operate with 120 V control circuits. The control circuit fuse shall be on the secondary side of the control transformer.
- 2.2.12 Provide an engraved lamacoid nameplate for the motor control centre and each individual starter within the motor control centre. M.C.C. identification shall be 50 mm (2 in.) high letters. All other identified shall be 6 mm (1/4 in.) high letters.

Typical Identification Plate for Motor Control Centre

First Line	-	M.C.C. #1
Second Line	-	Voltage/Phase/# of Wires
Third Line	-	Fed from main secondary switchboard
Fourth Line	-	In main electrical room

Typical Identification Plate for Individual Starters

First Line	-	Supply Fan SF-1
Second Line	-	Voltage/Phase/# of Wires

2.2.13 All nameplates shall be fastened with self-tapping screws.

2.3 INDIVIDUAL STARTERS

2.3.1 Individual starters shall meet all requirements specified for M.C.C.'s except as noted below.

2.3.2 Individually mounted manual starters shall generally be the toggle operated type with quick-make, quick-break mechanism, heavy duty sliding contacts in E.E.M.A.C. 1 general purpose enclosure in all areas without sprinklers and in E.E.M.A.C.-2 (drip proof) enclosure in all areas with sprinklers, pilot lights in cover and cover engraved with ON-TRIP-OFF positions.

2.3.3 Manual starters installed in finished areas shall be as above except suitable for flush mounting with stainless or bronze coverplates.

2.3.4 All magnetic starters individually mounted, standard or combination type, shall be for operation with a 120 V AC control transformer and coil, three phase overload protection, pilot lights, reset and pushbuttons or selector switches on the cover. All magnetic starters shall have auxiliary contacts.

2.3.5 All combination starters individually mounted shall be combination fusible type complete with pilot lights, on/off selector and reset button on cover. All combination starters shall have auxiliary contacts.

2.3.6 Provide an engraved lamar nameplate for each individual starter. Identification shall be 6 mm (1/4 in.) high letters.

Typical Identification Plate

First Line	-	Exhaust Fan EF-1
Second Line	-	208 V/3 ph/3 W
Third Line	-	Fed from splitter #1

3 Execution

3.1 INSTALLATION

3.1.1 All wiring and starters provided by this Division shall comply with the requirements of the Electrical Division of the Specifications.

- 3.1.2 Refer to Electrical Drawings and Specifications for work provided under that Division.
- 3.1.3 This Division shall review the shop Drawings for the motor starters submitted by the Electrical Division to ensure that all field connections are shown, the motor horsepower are correct and that the motor control schematics reflect all requirements.
- 3.1.4 Unless otherwise stated, this Section shall be responsible for the complete supply, installation and wiring of all starters, fused and non-fused switches and circuit breakers, auxiliary 120 V controls such as relays and pushbutton stations for the equipment supplied under other Sections of this Division.
- 3.1.5 Use non-fused disconnect switches for local equipment isolation only (e.g. fan motor downstream of fused starter in M.C.C.) all other disconnect shall be fused.
- 3.1.6 Where required provide a galvanized steel hood over switches, M.C.C.'s and individual starters. Hoods shall be suitably reinforced and securely supported from the structure.

END OF SECTION

1. General

1.1 WORK INCLUDED

1.1.1 Conform to the Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 QUALITY ASSURANCE

1.2.1 The Variable Frequency Drive (VFD) manufacturing facility shall be ISO 9001 certified. The VFD shall be UL listed, Canadian UL listed and CSA listed.

1.2.2 Provide a minimum 100,000 hours mean time before failure (MTBF).

1.2.3 The manufacturer or their representatives shall be provided the project electrical power single line diagram, providing the data required by IEEE-519, to perform an analysis to initially demonstrate the supplied equipment will meet the IEEE standards after installation. If, as a result of the analysis, it is determined that additional filter equipment is required to meet the IEEE recommendations, then the cost of such equipment shall be included in the bid. A harmonic analysis shall be submitted with the approval drawings to verify compliance with the latest version of IEEE-519 voltage and current distortion limits as shown in table 10.2 and 10.3 at the point of common coupling (PCC). The PCC shall be defined as the consumer–utility interface or primary side of the main distribution transformer.

1.2.4 The term Variable Frequency Drive (VFD) shall be synonymous with Variable Speed Drives (VSD) and Adjustable Frequency Drives (AFD).

1.2.5 All Variable Frequency Drives for this project shall be of a single manufacturer for all fan and pump systems, including all components that require VFDs for pumps, etc.

1.3 RELATED WORK

1.3.1 For motors connected to variable frequency drives, refer to requirements of Section 15054 – ELECTRIC MOTORS.

2. Products

1.4 GENERAL REQUIREMENTS

1.4.1 Variable frequency drives (VFD) shall be Danfoss FC102 VLTHVAC, Allan-Bradley PowerFlex 700, Schneider Electric Altivar 71 and ABB ACH550 as specified herein for the fans, pumps, heat recovery wheels, and cooling tower fans designated on the schedules or in the respective specification sections to be variable speed.

- 1.4.2 All standard and optional features shall be included within the VFD enclosure, unless otherwise specified. The VFD's UL listing shall allow it to be mounted in a plenum or other air handling compartments.
- 1.4.3 The VFD shall be housed in a UL Type 1 ventilated enclosure for indoor applications, and Type 12 totally enclosed, gasketed enclosure for outdoor applications or if mounted in a plenum.
- 1.4.4 The VFD shall be a digitally controlled drive, using, the Pulse Width Modulation (PWM) technology with sensorless vector control. It shall utilize IGBTs in its inverter section.
- 1.4.5 The VFD shall allow the motor to produce full rated power at rated amps, RMS fundamental volts, and speed without using the motor's service factor when the motor's rated voltage is applied to the VFD input.
- 1.4.6 The VFD including all specified options shall be assembled by the ANSI/UL Standard 508 certified manufacturer for the building and assembly of option panels and the complete unit shall be tested to ANSI/UL Standard 508. Assembly of the option panels by a third-party panel shop shall not be acceptable. Where the components are separate, the appropriate CSA or C-UL stickers shall be applied to both the VFD and option panel. Both the VFD and option panel shall be manufactured in ISO 9001 certified facilities.
- 1.4.7 The VFD shall have 5% DC link reactors on both the positive and negative rails of the DC bus to minimize power line harmonics. VFD's without DC link reactors shall provide a minimum 5% impedance input line reactor.
- 1.4.8 The VFD's full load amp rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 160% of rated current for up to 0.5 second while starting.
- 1.4.9 The VFD shall be able to provide full torque at any selected frequency from 28 Hz to base speed to allow driving direct drive fans without derating.
- 1.4.10 Input and output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD. Switching rate may be up to 1 time per minute on the input and unlimited on the output. Disconnects located between the drive and the motor shall be interlocked into the VFD's safety circuitry.
- 1.4.11 An automatic motor adaptation test algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to run the test.
- 1.4.12 VFD power components shall be designed for 600VAC where intended for 575V/600V service. Components designed for 480VAC installed on 575V/600V service shall not be acceptable.

- 1.4.13 VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD efficiencies while reducing motor noise.
- 1.4.14 VFD's output switching shall be maintained within the requirements of NEMA standard MG1 part 30, VFD's with output exceeding 1000V shall employ DVDT output filters.
- 1.4.15 VFD shall be complete with power disconnect where drive power can be completely shut down at the unit.
- 1.5 PROTECTIVEFEATURES
 - 1.5.1 A minimum of Class 20 I2t electronic motor overload protection for single motor applications and thermal-mechanical overloads for multiple motor applications shall be provided.
 - 1.5.2 Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over-voltage, under-voltage, VFD over-temperature and motor over-temperature. The VFD shall display all faults in plain English. Codes shall not be acceptable.
 - 1.5.3 Protect the VFD from sustained power or phase loss. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal.
 - 1.5.4 The VFD assembly including all required options shall be rated for 100,000amp interrupting capacity (AIC).
 - 1.5.5 The VFD shall have built-in or externally mounted EMI electromagnetic filters to limit the EMI and RFI output from the VFD, designed to meet standard EN61800-3.
 - 1.5.6 The VFD shall have a wide operating supply power range and shall continue to operate without faulting or tripping until the input voltage reaches at least 70% VAC on 600 volt systems and 300 VAC on 208/230 volt systems and 539 VAC on 460 volt systems.
- 1.6 INTERFACE FEATURES
 - 1.6.1 Each VFD shall have the same operator's keypad, including digital display with Hand/Start, Off/Stop and Auto/Start, Help selector switches or buttons shall be provided to start and stop the VFD and determine the speed reference. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings. The keypad shall include a built-in real time clock with date function. Speed Transfer between Hand and Auto shall be "bumpless."

- 1.6.2 Each VFD shall include an open system communication protocol interface, either BACnet as defined by ANSI/ASHRAE standard 135-2001 or LONWorks as defined by ANSI/CEA standard 709.1 for seamless integration with Section 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS).
- 1.6.3 Run permissive circuit shall be provided to accept a "system ready" signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of sending an output signal as a start command to actuate external equipment before allowing the VFD to start.
- 1.6.4 The VFD shall be able to be programmed to sense the loss of load and signal a no load/broken belt warning or fault.
- 1.6.5 If the temperature of the VFD's heat sink rises to 80 Deg. C. (176 Deg. C.), the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. If the temperature of the heat sink continues to rise the VFD shall automatically reduce its output frequency to the motor. As the VFD's heat sink temperature returns to normal, the VFD shall automatically increase the output frequency to the motor and return the carrier frequency to its normal switching speed.
- 1.6.6 At least six programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
- 1.6.7 Under smoke control or special fire mode conditions, the VFD shall be able to be programmed to automatically default to a preset speed or bypass.
- 1.7 SERVICE CONDITIONS
 - 1.7.1 Ambient temperature, -10 Deg. C. to 40 Deg. C. (14 Deg. F. to 104 Deg. F.) without derating.
 - 1.7.2 0 to 95% relative humidity, non-condensing.
 - 1.7.3 Elevation to 1005 m (3300 ft.) without derating.
 - 1.7.4 AC line voltage variation, -10 to +10% of nominal with full output.
 - 1.7.5 No side clearance shall be required for cooling of any units. All power and control wiring shall be done from the bottom.

1.8 BYPASS

1.8.1 Provide a manual 3-contactor bypass, were indicated in schedules or specified, consisting of a door interlocked main fused disconnect pad lockable in the off position, a built-in motor starter and a four position DRIVE/OFF/BYPASS/TEST switch controlling three contactors. In the DRIVE position, the motor is operated at an adjustable speed from the VFD. In the OFF position, the motor and VFD are disconnected. In the BYPASS position, the motor is operated at full speed from the AC power line and power is disconnected from the VFD so that service can be performed. In the TEST position, the motor is operated at full speed from the AC line power while power is applied to the input of the VFD. This allows the VFD to be given an operational test while continuing to run the motor at full speed in bypass. In case of an external safety fault, a customer supplied normally closed dry contact shall be able to stop the motor whether in DRIVE or BYPASS mode. Supply VFD specific only fuses

1.8.1.1 .1 Service personnel shall be able to defeat the main power disconnect and open the bypass enclosure without disconnecting power. This shall be accomplished through the use of a specially designed tool and mechanism while meeting all local and national code requirements for safety.

3. Execution

1.9 INSTALLATION

1.9.1 Comply with manufacturer's installation instructions.

1.9.2 Provide a disconnect switch at the motor where required by the authorities having jurisdiction. Where such a switch is installed, provide an auxiliary contact or switch at the disconnect, mounted to open when the disconnect switch is opened and wired to a terminal strip in the VFD such that opening the disconnect switch initiates a drive shut down and prevents the drive from starting in either Line or Drive positions.

1.9.3 Locate and mount VFD panels in Mechanical Rooms and/or where shown on the Drawings.

1.9.4 Arrange for manufacturer's technical representative or local qualified representative to:

1.9.4.1 Inspect the installation of the drives and to start-up

1.9.4.2 Test and commission the drives. The VFD shall operate a dynamometer at full load and speed and shall be cycled during the test.

1.9.4.3 Be present during testing and commissioning performed under Section 25 01 10 – BUILDING AUTOMATION SYSTEM (BAS).

1.9.5 Measure the distortion of each phase at the load terminals of the branch breaker and report the results to the Owner. Any deficiency shall be corrected and re-evaluated.

- 1.9.6 Implement a communication protocol for remote interface to match the communication protocol under Section 23 09 00.00 – BUILDING AUTOMATION SYSTEM (BAS).
- 1.9.7 BAS connection to drives provided under Section 23 09 00.00 – BUILDING AUTOMATION SYSTEM (BAS).
- 1.10 WARRANTY
 - 1.10.1 Warranty shall be 24 months from the date of Substantial Performance of the work. Warranty shall be on-site parts and labour inclusive.

END OF SECTION

1. General

1.1. WORK INCLUDED

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

- .1 Shop Drawings: Further to requirements of Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS, submit working ranges of thermometers and gauges with Shop Drawings.

2. Products

2.1. MATERIALS

- .1 Pipeline thermometers shall be complete with:
 - .1 Dust-tight stainless case and stem with 127 mm (5 in.) dial.
 - .2 Bi-metal type.
 - .3 Whiteface with black lettering
 - .4 Range normally 0 to 115 deg. C. (32 to 240 deg. F.) for hot water, range shall suit maximum and minimum temperatures of location and be shown on shop drawings.
 - .5 Temperature marking in 1 deg. C. (2 deg. F.) increments in both imperial and metric scales.
 - .6 Eternal recalibration adjustment.
 - .7 Separable socket with extension neck as required for insulated pipe.
 - .8 Universal adjustable hinge
 - .9 Wells shall be registered with the provincial Boiler and Pressure Vessel Safety Branch and have a C.R.N. registration number.
- .2 For ducts up to 750 mm (30 in.) in the largest dimension thermometers shall be similar to pipeline thermometers but with an additional perforated bulb guard and shall be flanged for mounting on ducts.
- .3 For ducts over 750 mm (30 in.) in largest dimension thermometer shall be complete with:
 - .1 115 mm (4½ in.) diameter, cast aluminum case construction
 - .2 Black pointer
 - .3 Whiteface with black lettering
 - .4 Range normally 0 to 115 deg. C. (32 to 240 deg. F.) for heated supply air, 0 to 80 deg. C. (32 to 175 deg. F.) for cooled supply, mixed and return air and –40 to 90 deg. C. (–40 to 195 deg. F.) for outside air but range shall suit maximum and minimum temperature of location and shall be shown on Shop Drawings.
 - .5 Temperature marking in 1 deg. C. (2 deg. F.) increments in both imperial and metric

- scales.
- .6 Vapour filled
- .7 1500 mm (60 in.) minimum length copper averaging bulb with bronze braided armour.
- .8 Flanged for mounting on ducts.
- .9 For insulated ducts or plenums provide a bracket for mounting thermometer clear of insulation.
- .4 Thermometers for remote reading shall be similar to duct thermometers specified above but with armoured extension capillary and bulb with separable well for pipelines or flanged duct connection for averaging bulb, as required.
- .5 Pressure gauges shall be complete with:
 - .1 Dust-tight nominal 115 mm (4½ in.) dia. case, solid front complete with back blow-out to A.N.S.I. B40-1 Grade 2A Level Standards.
 - .2 Back-flanged where required.
 - .3 Black pointer
 - .4 White dial with black markings
 - .5 Dial range to cover twice the average working pressure of the equipment and shall be compound gauges on pump suction for all open systems.
 - .6 Clear lens
 - .7 Phosphor bronze bourdon tube, silver soldered.
 - .8 Brass or stainless steel movement, bronze or nylon brushed, scale and movement mounted independent of the case.
 - .9 Brass socket
 - .10 kPa and psi scales
 - .11 Provincial Boiler and Pressure Vessel Safety Branches registration number
- .6 Manometers shall be inclined tube, differential type complete with:
 - .1 Adjustable scale of anodized aluminum or polished and chrome plated with black figure and graduations
 - .2 Range 0 to 0.5 kPa (0 to 2 in.) with 0.005 kPa (0.02 in.) graduations in both metric and imperial scales.
 - .3 Built in level vial
 - .4 Adjustable flanged base for mounting on duct or plenum
 - .5 Two static pressure tips, flanged for mounting on duct
 - .6 Two 1500 mm (60 in.) lengths of tubing
 - .7 Bottle of red gauge oil
- .7 Manometers shall be Magnahelic gauge type in dust free case with black pointer. Gauge range shall be 2½ times the maximum filter resistance. Case shall be suitable for duct or plenum mounting. Provide bracket for mounting gauge on insulated ducts or plenums.

- .8 Thermometers shall be Trerice, Taylor, Weksler, Winters or Ashcroft.
- .9 Pressure gauges shall be Trerice, Ashcroft, Morrison, Winters or Weksler.
- .10 Manometers shall be Airflow Developments or Dwyer.
- .11 Gauge glasses shall be Pyrex Red Line 12 mm (1/2 in.) equipped with leakproof pet cocks and ball check valves.

3. Execution

3.1. INSTALLATION

- .1 Locate all thermometers and pressure gauges so as to assure easy reading from the floor or platform.
- .2 Where direct reading instruments cannot be satisfactorily located use a remote instrument.
- .3 Locate remote instruments next to the point of the reading, on wall or structure.
- .4 Each remote or panel mounted instrument shall have an engraved lamaroid nameplate identifying the system and service.
- .5 Insert pipeline thermometer into tanks, equipment tapings or in pipeline using screwed tees or forged steel couplings, welded into the lines.
- .6 Duct thermometers shall be attached to duct using sheet metal screws through thermometer flange.
- .7 Insert pressure gauges into equipment tapings or in pipelines using screwed tees or forged steel couplings welded into the lines.
- .8 Provide thermometers in the following locations in pipelines:
 - .1 In and out of each water coil or other coil, handling liquid, except individual reheat coils in ductwork.
 - .2 On each branch of 3 port control valves, excluding valves on fan coil, induction units, or individual reheat coils in ductwork.
 - .3 In and out of each heat exchanger, condenser, cooler or type of other heat exchanger.
 - .4 Each heating water return and each heating water supply for each main system
 - .5 Each hot or cold water storage tank
 - .6 And where specifically shown
- .9 When a common supply header provides the same temperature water to many coils or to many zones, provide a thermometer on the common header only, rather than a

thermometer on each branch.

- .10 For control valves with by-pass located thermometer in common pipe to allow for manual temperature control.
- .11 Provide thermometers in the following locations in ducts or plenums:
 - .1 Upstream and downstream from each coil, except individual reheat coils in ductwork.
 - .2 On each of 3 ducts or plenums at mixing dampers
 - .3 Return air from each zone
 - .4 Outside air entering air handling units
 - .5 And where specifically shown
- .12 Where a common duct or plenum provides the same temperature air to many zones, provide a thermometer on the common duct only, rather than at each branch of a zone.
- .13 Provide test wells for thermometers where shown. Test wells shall be compatible with the thermometers used. Wells shall be registered with the Provincial Boiler and Pressure Vessel Safety Branch and have a C.R.N. registration number.
- .14 Provide a Watts B6000 ball valve on the inlet to each gauge. In addition, install a coil syphon on each steam gauge. Install a pressure snubber on any gauge installed near a pump or in any location where damping is required to prevent rapid oscillation of the pointer. When the equipment is subject to vibration, mount the gauge on adjacent wall or on a mounting plate, supported from the floor.
- .15 Provide pressure gauges in the following areas:
 - .1 City water line where it enters the building
 - .2 In and out of each pump
 - .3 In and out of all pressure reducing valves
 - .4 On each hot water supply and hot water return header
 - .5 Air cushion tank or expansion tank
 - .6 City water make-up line
 - .7 In and out of each heat exchanger, condenser, cooler or type of other heat exchanger
 - .8 And where specifically shown
- .16 Valved connections for pressure gauges shall be installed on each side of coils.
- .17 Install manometer at each bank of filters to show the resistance to air flow through the filters. Where prefilters and final filters are mounted in a common frame it is only necessary to provide a single manometer to show the resistance across the total filter assembly.

Where filters are separately mounted in individual frames provide a manometer for each set of filters.

- .18 Install gauge glasses on each expansion tank and where shown. Gauge glasses shall be full height of tank. Individual gauge glasses shall be a maximum of 450 mm (18 in.) high where more than one gauge glass is required to give full coverage on any tank, glasses shall overlap by a minimum of 150 mm (6 in.). Provide shut-off valves on all connections to gauge glasses.

END OF SECTION

1 GENERAL

1.1 THIS SECTION REFERENCES TO PLUMBING, HEATING AND FIRE PROTECTION PIPE HANGERS AND SUPPORTS AND APPLIES TO DIVISIONS 21, 22 AND 23.

1.2 REFERENCES

1.2.1 ANSI B31.1-1983, (SI), Power Piping, (SI Edition).

1.2.2 ANSI/MSS-SP-58-1983, Pipe Hangers and Supports - Materials, Design and Manufacture.

1.3 SHOP DRAWINGS AND PRODUCT DATA

1.3.1 Submit shop drawings and product data in accordance with Section 23 01 20 Mechanical Submittals.

1.3.2 Indicate on manufacturers catalogue literature the following:

1.3.2.1 Upper attachment.

1.3.2.2 Middle attachment.

1.3.2.3 Pipe attachment.

1.3.2.4 Riser clamps.

1.3.2.5 Shields and saddles.

1.3.2.6 Sway braces.

1.4 MAINTENANCE DATA

1.4.1 Provide maintenance data for incorporation into manual specified in Section 23 01 20 - Mechanical Submittals.

2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

2.1.1 Supports and Hangers: E. H. Myatt & Co., Grinnell, Hunt Manufacturing, L.E. Taylor.

2.2 GENERAL

2.2.1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS-SP58.

2.2.2 Support from top of structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.

2.3 UPPER ATTACHMENTS

2.3.1 Concrete:

- 2.3.1.1 Inserts for cast-in-place concrete: galvanized steel wedge to MSS-SP58, type 18. ULC listed for pipe NPS 3/4 through NPS 8.
 - 2.3.1.1.1 Acceptable Material: Grinnell fig. 281.
- 2.3.1.2 Carbon steel plate with clevis, for surface mount: malleable iron socket and expansion case and bolt. Minimum two expansion cases and bolts for each hanger.
 - 2.3.1.2.1 Acceptable Material: Grinnell, Plate Fig. 49, Socket fig. 290, Expansion Case fig.117.
- 2.3.2 Steel beam (bottom flange):
 - 2.3.2.1 Cold piping NPS 2 and under: malleable iron C clamp to MSS-SP58, type 19. ULC listed.
 - 2.3.2.1.1 Acceptable Material: Grinnell fig. 61.
 - 2.3.2.2 Cold piping NPS 2-1/2 and larger and all hot piping: malleable iron beam clamp to MSS-SP58, type 28 or 29. ULC listed.
 - 2.3.2.2.1 Acceptable Material: Grinnell fig. 229.
- 2.3.3 Steel beam (top):
 - 2.3.3.1 Cold piping NPS 2 and under: malleable iron "top of beam" C clamp to MSS-SP58, type 19. ULC listed.
 - 2.3.3.1.1 Acceptable Material: Grinnell fig. 61.
 - 2.3.3.2 Cold piping NPS 2-1/2 and larger and all hot piping: steel jaw, hook rod with nut, spring washer and plain washer, to MSS-SP58, type 25. ULC listed.
 - 2.3.3.2.1 Acceptable Material: Grinnell fig. 227.
- 2.3.4 Steel joist:
 - 2.3.4.1 Cold piping NPS 2 and under: steel washer plate with double locking nuts.
 - 2.3.4.1.1 Acceptable Material: Grinnell fig.60.
 - 2.3.4.2 Cold piping NPS 2-1/2 and larger and all hot piping: steel washer plates with double locking nut, carbon steel clevis and malleable iron socket.
 - 2.3.4.2.1 Acceptable Material: Grinnell. washer plate, fig. 60; clevis, fig.66; socket, fig.290.
- 2.3.5 Steel channel or angle (bottom):
 - 2.3.5.1 Cold piping NPS 2 and under; malleable iron C clamp to MSS-SP58, type 23. ULC listed.
 - 2.3.5.1.1 Acceptable Material: Grinnell fig. 86.

- 2.3.5.2 Cold piping NPS 2-1/2 and larger and all hot piping; universal channel clamp. ULC listed.
 - 2.3.5.2.1 Acceptable Material: Grinnell fig. 226.
- 2.3.6 Steel channel or angle (top):
 - 2.3.6.1 Cold piping NPS 2 and under; malleable iron "top of beam" C clamp to MSS-SP58, type 19. ULC listed.
 - 2.3.6.1.1 Acceptable Material: Grinnell fig. 61.
 - 2.3.6.2 Cold piping NPS 2-1/2 and larger and all hot piping: steel jaw, hook rod with nut, spring washer and plain washer, to MSS-SP58, type 25. ULC listed.
 - 2.3.6.2.1 Acceptable Material: Grinnell fig. 227.
- 2.3.7 Carbon steel threaded rod black finish.
- 2.3.8 Cold piping, steel or cast iron: hot piping steel, with less than 25 mm horizontal movement; hot piping, steel, with more than 300 mm middle attachment (rod) length: adjustable clevis to MSS-SP58, type 1. ULC listed.
 - 2.3.8.1 Acceptable Material: Grinnell fig. 260.
- 2.3.9 Cold copper piping; hot copper piping with less than 25 mm horizontal movement; hot copper piping with more than 300 mm middle attachment (rod) length: adjustable clevis to MSS-SP58, type 1. Copper plated.
 - 2.3.9.1 Acceptable Material: Grinnell fig. CT-65.
- 2.3.10 Suspended hot piping, steel and copper, with horizontal movement in excess of 25 mm; hot steel piping with middle attachment (rod) 300 mm or less; pipe roller to MSS-SP58, type 43.
 - 2.3.10.1 Acceptable Material: Grinnell fig. 174.
- 2.3.11 Bottom supported hot piping, steel and copper: pipe roller stand to MSS-SP58, type 45.
 - 2.3.11.1 Acceptance Standard: Grinnell fig. 271.
- 2.3.12 Steel or cast iron pipe: black carbon steel to MSS-SP58, type 42. ULC listed.
 - 2.3.12.1 Acceptable Material: Grinnell 261.
- 2.3.13 Copper pipe: carbon steel copper finished to MSS-SP58, type 42.
 - 2.3.13.1 Acceptable Material: Grinnell fig. CT-121.

2.4 SADDLES AND SHIELDS

2.4.1 Cold piping NPS 1-1/4 and over: protection shield with high density insulation under shield with uninterrupted vapor barrier.

2.4.1.1 Acceptable Material: Grinnell fig. 167.

2.4.2 Hot piping NPS 1-1/4 and over: protective saddle with insulation under saddle.

2.4.2.1 Acceptable Material: Grinnell fig. 160 to 166.

3 EXECUTION

3.1 HANGER SPACING

3.1.1 SPACING and middle attachment (rod) diameter as specified in paragraphs below or as in table below, whichever is more stringent.

3.1.1.1 Plumbing piping: most stringent requirements of Canadian Plumbing Code, Provincial Code, or authority having jurisdiction.

3.1.1.2 Fire protection: to applicable fire code.

3.1.1.3 Gas piping: up to NPS 1/2: every 1.8 m.

3.1.1.4 Copper piping: up to NPS 1/2: every 1.5 m.

3.1.1.5 Flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.

3.1.1.6 Within 300 mm of each horizontal elbow.

Pipe Size NPS Up to:	Rod Diameter	Maximum Steel	Spacing Copper
3/4	10 mm	2.1 m	1.8 m
1	10 mm	2.1 m	1.8 m
1-1/4	10 mm	2.1 m	1.8 m

Pipe Size NPS Up to:	Rod Diameter	Maximum Steel	Spacing Copper
1-1/2	10 mm	2.4 m	2.1 m
2	10 mm	3 m	2.7 m
2-1/2	10 mm	3.6 m	3 m
3	10 mm	3.6 m	3 m
3-1/2	10 mm	3.9 m	3.3 m
4	16 mm	4.8 m	3.3 m
5	16 mm	4.8 m	3.3 m
6	22 mm	5.1 m	3.3 m
8	22 mm	5.7 m	3.3 m
10	22 mm	6.6 m	3.3 m
12 & over	22 mm	6.7 m	3.3 m

3.2 HANGER INSTALLATION

3.2.1 Offset hanger so that rod is vertical in operating position.

3.2.2 Adjust hangers to equalize load.

END OF SECTION

1 GENERAL

1.1 REFERENCES

1.1.1 ANSI/NFPA 13-1987, Installation of Sprinkler Systems.

1.1.2 BC Building Code 2012.

1.2 SHOP DRAWINGS

1.2.1 Submit shop drawings in accordance with Section 23 01 20 - Mechanical Submittals.

1.2.2 Provide separate shop drawings for each isolated system complete with performance and product data.

1.2.3 Provide detailed drawings of all seismic control measures for equipment and piping.

2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

2.1.1 Vibration Isolation Material: Korfund, Masdom, Vibron, Vibro - Acoustics.

2.2 ELASTOMERIC PADS

2.2.1 Type P1 - neoprene waffle or ribbed; 9 mm minimum thick; 50 durometer; maximum loading 350 kPa.

2.2.2 Type P2 - rubber waffle or ribbed; 9 mm minimum thick; 30 durometer natural rubber; maximum loading 415 kPa.

2.2.3 Type P3 - neoprene-steel-neoprene; 9 mm minimum thick neoprene bonded to 1.71 mm steel plate; 50 durometer neoprene, waffle or ribbed; holes sleeved with isolation washers; maximum loading 350 kPa.

2.2.4 Type P4 - rubber-steel-rubber; 9 mm minimum thick rubber bonded to 1.71 mm steel plate;

2.2.5 30 durometer natural rubber, waffle or ribbed; holes sleeved with isolation washers; maximum loading 415 kPa.

2.3 SPRING MOUNT

2.3.1 Zinc or cadmium plated hardware; housings coated with rust resistant paint.

2.3.2 Type M2 - stable open spring: support on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad.

- 2.3.3 Type M3 - stable open spring: 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad, bonded under isolator and on isolator top plate; levelling bolt for rigidly mounting to equipment.
- 2.3.4 Type M4 - restrained stable open spring: supported on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad; built-in resilient limit stops, removable spacer plates.
- 2.3.5 Type M5 - enclosed spring mounts with snubbers for isolation up to 950 kg maximum.

2.4 HANGERS

- 2.4.1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30E arc without metal to metal contact.
- 2.4.2 Type H1 - neoprene - in-shear, molded with rod isolation bushing which passes through hanger box.
- 2.4.3 Type H2 - stable spring, elastomeric washer, cup with molded isolation bushing which passes through hanger box.
- 2.4.4 Type H3 - stable spring, elastomeric element, cup with molded isolation bushing which passes through hanger box.
- 2.4.5 Type H4 - stable spring, elastomeric element with precompression washer and nut with deflection indicator.

3 EXECUTION

3.1 INSTALLATION

- 3.1.1 Install vibration isolation equipment in accordance with manufacturer's instructions and adjust mountings to level equipment.
- 3.1.2 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.
- 3.1.3 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm minimum static deflection as follows:
 - 3.1.3.1 up to NPS 4: first 3 points of support. NPS 5 to NPS 8: first 4 points of support. NPS 10 and Over: first 6 points of support.
 - 3.1.3.2 First point of support shall have a static deflection of twice deflection of isolated equipment, but not more than 50mm.
- 3.1.4 Where isolation is bolted to floor use vibration isolation rubber washers.

3.2 ISOLATION SCHEDULE

<u>Equipment Description</u>	<u>Equipment No.</u>	<u>Isolation</u>	<u>Deflection Type</u>	<u>Comments Static (mm)</u>
Ventilation Units	VU-1 VU-2	M-3 M-3	25 mm 20 mm	By equipment supplier
Pumps	P-1 to P-4	P-2	-	-

END OF SECTION

1 GENERAL

1.1 SCOPE

- 1.1.1 Notwithstanding the Rules, Regulations, and Trade Definitions of the BC Construction Tendering System, all Mechanical Identification shall be included in the Mechanical scope of work.

1.2 REFERENCES

- 1.2.1 CAN/CGSB-1.60-M89, Enamel, Interior, Gloss, Alkyd Type.
- 1.2.2 CAN/CGSB-24.3-92, Identification and Classification of Piping Systems.

2 PRODUCTS

2.1 MANUFACTURERS NAMEPLATES

- 2.1.1 Provide metal nameplate on each piece of equipment, mechanically fastened complete with raised or recessed letters.
- 2.1.2 Indicate size, equipment model, manufacturer's name, serial number, voltage, cycle, phase and power of motors.

2.2 SYSTEM NAMEPLATES

2.2.1 Colour:

- 2.2.1.1 Hazardous: red letters, white background.
- 2.2.1.2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).

2.2.2 Construction:

- 2.2.2.1 3 mm thick, laminated plastic or white anodized aluminum, matte finish, square corners, letters accurately aligned and machine engraved into core.

2.2.3 Sizes:

2.2.3.1 Conform to following table:

Size #	Dimensions (mm x mm)	No of Lines	Letter Height (mm)
1	10 x 50	1	3
2	13 x 75	1	5
3	13 x 75	2	3
4	20 x 100	1	8
5	20 x 200	1	8
6	20 x 100	2	5

7	25 x 125	1	12
8	25 x 125	2	8
9	35 x 200	1	20

2.2.3.2 Use average of 25 letters/numbers (maximum) per nameplate.

2.2.3.3 Use size #6 for terminal cabinets and control panels.

2.2.3.4 Use size #9 for equipment in mechanical rooms.

2.3 PIPING AND DUCTING

2.3.1 General:

2.3.1.1 Use painted stencils for labels and flow arrows for all insulated and non-insulated piping.

2.3.1.2 Identify pipes and ducts with striped bands and symbols.

2.3.1.3 Piping and ductwork painting to be done by painting sub-contractor to the requirements of Division 9.

2.3.2 Sizes:

2.3.2.1 Legend: block capitals to following table:

Outside Dia. of Pipe or Insulation mm	Size of Letters mm
30	13
50	19
150	32
250	63
Over 250	88

2.3.2.2 Primary colour bands:

2.3.2.2.1 At valves and fittings: 500 mm long.

2.3.2.2.2 Elsewhere: 1000 mm long.

2.3.2.3 Secondary colour bands: 50 mm wide, 75 mm in from one end of primary colour band.

2.3.2.4 Arrows:

2.3.2.4.1 Outside diameter of pipe/duct/insulation 75 mm and greater: 150 mm long x 50 mm high.

2.3.2.4.2 Outside diameter of pipe/duct/insulation less than 75 mm: 100 mm long x 50 mm high.

2.3.2.4.3 Use double headed arrows where flow is reversible.

2.3.3 Colours:

2.3.3.1 Where not covered by table below, submit legend, primary and secondary classification colours to Owner for approval.

2.3.4 Table:

2.3.4.1 Pipe and Duct identification.

Classification	<u>Pipe/Duct Colour</u>	<u>Symbol</u>
Heating Water Supply Pipe	Yellow	HWS
Heating Water Return Pipe	Yellow	HWR
Domestic Cold Water Pipe	Dark Green	DCW
Domestic Hot Water Supply Pipe	Light Grey	DHWS
Domestic Hot Water Return Pipe	Dark Grey	DHWR
Drain Pipe	Black	
Glycol Supply Pipe	Orange	GLY.S
Glycol Return Pipe	Orange	GLY.R
Gas Pipe (Low Pressure)	Dark Blue	NAT.GAS
Gas Pipe (Medium Pressure)	Yellow	NAT.GAS
Supply Air Duct		S/A
Return Air Duct		R/A
Exhaust Air Duct		E/A

2.3.4.2 Legend and arrows:

2.3.4.2.1 Black or white to contrast with primary colour.

2.3.4.2.2 Fire protection: white on red background. Stopped here

2.3.5 Fire protection system:

2.3.5.1 Concealed piping: paint complete system red (by Division 9) and identify.

2.3.6 Natural gas:

- 2.3.6.1 Paint entire system as per Pipe and Duct Identification Schedule.
Coordinate painting with Division 9.

2.3.7 All other piping and ducting: paint where exposed in mechanical rooms (by Division 9) and identify completely.

2.3.8 Low voltage control wiring installed by Division 15: to Section 15994 – BAS General Requirements.

2.4 Valves AND CONTROLLERS

- 2.4.1 Brass tags with 12 mm stamped code lettering and numbers filled with black paint.

2.5 CONTROLS IDENTIFICATION

- 2.5.1 Identify all systems, equipment, components, controls and sensors with laminated plastic tag indicating point identification name, point address (program name), control panel, control panel location.

- 2.5.2 Inscription to identify function and, (where applicable) fail-safe position.

3 EXECUTION

3.1 GENERAL

- 3.1.1 Provide ULC and or CSA registration plates, as required by respective agency.

3.2 LOCATION OF NAMEPLATES

- 3.2.1 In conspicuous location to facilitate easy reading from operating floor and to properly identify equipment and/or system.

- 3.2.2 Provide stand-offs for nameplates on hot surfaces and insulated surfaces.

- 3.2.3 Do not insulate or paint over plates.

3.3 PIPING

- 3.3.1 Identify all piping using primary color bands, secondary color bands and pipe marker legend text.

- 3.3.2 Locations:

- 3.3.2.1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, and tunnels so that at least one is clearly visible from any one viewpoint in operating areas or walking aisles and not at more than 10 m intervals.

- 3.3.2.2 Adjacent to all changes in direction.

- 3.3.2.3 At least once in each small room through which piping passes.
- 3.3.2.4 On both sides of visual obstruction or where run is difficult to follow.
- 3.3.2.5 On both sides of any separation such as walls, floors and partitions.
- 3.3.2.6 Where piping is concealed in pipe chase, ceiling space, gallery or other confined space, at entry and leaving points and adjacent to each access opening.
- 3.3.2.7 At beginning and end points of each run and at each piece of equipment in run.
- 3.3.2.8 At point immediately upstream of major manually operated or automatically controlled valves. Where this is not possible, place identification as close to valve as possible, preferably on upstream side.
- 3.3.2.9 Legend to be easily and accurately readable from usual operating areas and all readily accessible points.
- 3.3.2.10 Plane of legend to be approximately at right angles to most convenient line of sight with consideration of operating positions, lighting conditions, reduced visibility of colour or legends caused by dust and dirt and risk of physical damage.

3.4 DUCTWORK

- 3.4.1 Identify all ductwork by name and indicate direction of flow using arrows.
- 3.4.2 Stencil over final finish only.
- 3.4.3 Locations of ductwork identification:
 - 3.4.3.1 On long straight runs in open areas in boiler rooms so that at least one is clearly visible from any one viewpoint in operating areas or walking isles and not at more than 10 m intervals.
 - 3.4.3.2 Adjacent to all changes in direction.
 - 3.4.3.3 At least once in each small room through which ductwork passes.
 - 3.4.3.4 On both sides of visual obstruction or where run is difficult to follow.
 - 3.4.3.5 On both sides of any separation such as walls, floors and partitions.
 - 3.4.3.6 Where ductwork is concealed in duct chase, gallery or other confined space, at entry and leaving points and adjacent to each access opening.
 - 3.4.3.7 At beginning and end points of each run and at each piece of equipment in run.
 - 3.4.3.8 At point immediately upstream of major manually operated or automatically controlled dampers. Where this is not possible, place identification as close to damper as possible, preferably on upstream side.
 - 3.4.3.9 Legend to be easily and accurately readable from usual operating areas and all readily accessible points.
 - 3.4.3.10 Plane of legend to be approximately at right angles to most convenient line of sight with consideration of operating positions, lighting conditions, reduced visibility of colour or legends caused by dust and dirt and risk of physical damage.

3.4.3.11 Beside each access door.

3.5 VALVES AND CONTROLLERS

3.5.1 Secure tags with non-ferrous chains or closed "S" hooks for valves and operating controllers except at plumbing fixtures and radiation.

3.5.2 Consecutively number valves in system.

END OF SECTION

1 General

1.1 WORK INCLUDED

1.1.1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.1.2 Nameplates for systems such as thermostatic controls, are covered in the Articles specifying the equipment.

1.1.3 Every piece of equipment shall have a nameplate.

1.2 SUBMITTALS

1.2.1 Submit samples of nameplates before installation.

2 Products

2.1 MATERIALS

2.1.1 The nameplates shall be a minimum of 2 mm (3/32 in.) thick laminated phenolic plastic. Minimum size shall be 100 mm (4 in.) long x 50 mm (2 in.) wide with maximum size to suit nomenclature required. Nameplate shall be with black face and white centre and with 5 mm (7/32 in.) high lettering engraved through to the white lamination.

2.1.2 The nameplates shall have the equipment type and name as indicated in the Equipment Schedules.

2.1.3 The nameplates shall have the service and area of the building served (e.g. Chilled Water – South Zone).

3 Execution

3.1 INSTALLATION

3.1.1 Nameplates shall be securely fastened with screws or brass chains in a conspicuous place on the equipment.

END OF SECTION

1. General

1.1. WORK INCLUDED

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

- .1 Submit samples of charts and numbering system before installation.

2. Products

2.1. MATERIALS

- .1 Tags shall be square colour coded phenolic with engraved numbers and/or letters as required. Tags shall be a minimum of 25 mm (1 in.) square and maximum to suit numbering system. Numbers shall be nominally 9 mm (3/8 in.) high. Letters shall be nominally 6 mm (1/4 in.) high.
- .4 Abbreviations and colour code shall be as shown on Standard Details.

3. Execution

3.1. INSTALLATION

- .1 Tags and nameplates shall be attached to the valve body or handle with brass hooks or chains.
- .2 All valves shall be provided with tags, other than valves on convectors, induction units or other space heating, cooling units and valves on plumbing fixtures. Provide a chart or charts, indicating location, service and zone of each valve. This work shall be coordinated between the various Mechanical Sections to prevent overlapping of numbering systems.
- .3 Provide separate charts for all fire system nameplates and tags.
- .4 For extension and/or alterations to existing systems, provide new charts conforming in appearance to the existing charts.
- .5 Co-ordinate valve identification with pipe and ductwork identification.

Remove Restriction Device”.

- .7 Charts shall be set in metal picture frames with a clear acrylic front and fastened securely where directed by Owner or Owner.
- .8 All valve tag numbers for all systems shall be shown on the As-Built Drawings.

END OF SECTION

1 General

1.1 WORK INCLUDED

- 1.1.1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.1.2 Submit Drawings showing size, type and location of all access doors, for review, before installation.

2 Products

2.1 MATERIALS

- 2.1.1 Access doors shall be Acudor, or Mifab Manufacturing Inc.
- 2.1.2 Doors in solid walls shall be with a 14 U.S. gauge, prime painted steel door panel, rust resistant concealed hinges, flanged frame, and screwdriver operated lock. Acudor Model UF 5000 or Mifab Model UA.
- 2.1.3 Doors in plaster partitions or ceilings shall be with a 16 US gauge, prime painted steel recessed door panel with metal lath for the acceptance of plaster finish, concealed hinges, metal lath frame, and screwdriver operated lock. Acudor model AP 5010 or Mifab Model CAD-PL.
- 2.1.4 Doors in drywall partitions or ceilings shall be 16 US gauge, prime painted steel recessed door panel for the acceptance of a drywall insert, concealed hinges, drywall bead frame, and screwdriver operated lock. Acudor model DW 5015 or Mifab Model CAD-DW.
- 2.1.5 Doors in drywall partitions or ceilings shall be 14 US gauge, prime painted steel flush door panel, concealed hinges, drywall bead frame, and screwdriver operated lock. Acudor model DW 5040 or Mifab Model MDW.
- 2.1.6 Access doors in fire rated walls or ceilings shall be ULC labeled with insulated door panel, concealed hinge, self closing, self latching, flanged frame, and prime painted. Provide master key operated catch in areas accessible to the public. Acudor Model FW 5050 or Mifab MPFR.
- 2.1.7 Doors in tiled walls or ceilings shall be 16 US gauge, stainless steel, type 304 with #4 satin finish, concealed hinges, wall frame and screw driver operated lock. Acudor Model UF 5000 or Mifab Model UA-SS.
- 2.1.8 Doors for medium and high security applications in solid walls shall be 10 US gauge door with minimum 4 mm (3/16 in.) welded angle frame with heavy duty butt hinges welded to the door and frame with master keyed cylinder lock provided by the Owner. Acudor Model SD 6000 or Mifab Model MI-SADH.

- 2.1.9 Minimum size of doors shall be 300 mm x 450 mm (12 in. x 18 in.). Wherever possible 600 mm x 600 mm (24 in. x 24 in.) doors shall be used.

3 Execution

3.1 INSTALLATION

- 3.1.1 All parts of the installation requiring periodic maintenance shall be accessible. Wherever valves, dampers and other appurtenances are concealed by building construction, access doors shall be furnished by this Section and installed under the respective Trade Sections (i.e. masonry, plaster, drywall, tile, etc.) This Section is responsible for the proper location of the access doors.
- 3.1.2 Wall mounted plumbing fixtures with back water connection shall have an adjacent access door.
- 3.1.3 Wherever possible, items requiring access shall be located in easily accessible areas (i.e. exposed or T-bar ceilings).
- 3.1.4 Group items in order to minimize the number of access doors required.
- 3.1.5 Each access door shall be installed to provide complete access to equipment for maintenance and servicing.
- 3.1.6 Make any changes to locations of access doors as directed by the Owner.
- 3.1.7 The final installed locations of all access doors shall be shown on the As-Built Record Drawings.

END OF SECTION

1. General**1.1. WORK INCLUDED**

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 This Section governs requirements for all excavating and backfilling Work required for the installation of buried storm drains, sanitary sewers, gas lines, water lines, and appurtenances associated with such services. Excavation and backfill includes all work within building footprint (plan), and extends to a point 1500 mm (5 ft. 0 in.) beyond face of building foundation line.
- .3 Assume that material to be excavated is earth. When rock is encountered during construction, payment will be made on unit price basis to the extent of net difference in cost between dry earth excavation and solid rock excavation, all as indicated in Contract Documents.

1.2. RELATED WORK SPECIFIED ELSEWHERE

- .1 Removing subgrade materials for service trenches inside and outside building perimeter, for general grade adjustments, and backfilling of trenches from top of bedding up to bottom of slab-on-grade – under Division 31. (under separate Contract).
- .2 Dewatering of Site – under Division 31.
- .3 Rock excavating and spreading – under Division 31.
- .4 Finish grading and spreading of topsoil – under Division 31.
- .5 Weeping tile drainage lines and filter media – under Division 31.

1.3. SUBMITTALS

- .1 Provide Shop Drawings indicating proposed method of bedding and backfilling.

2. Products**2.1. SOILS**

- .1 To the requirements for Granulars "A", "B" (Type 1), "M" and "Select Subgrade Material"; Ontario Provincial Standard Specifications (OPSS), Form No. 1010 for Granulars "A", "B", "M" and "Select Subgrade" material.
- .2 Requirements for Pea Gravel: Granular, well-graded clean rounded pea gravel or stone with not more the 2% material that will pass 75 um (No. 200) sieve, maximum 6 mm (¼ in.), containing not other deleterious material, and subject to testing that specified density can be achieved without compaction.
- .3 Requirements for Sand Fill: Uniform quality and unwashed river sand or any clean sand containing less than 5% organic materials, clay or silt (passing 125 um sieve) is acceptable. It can contain a limited amount of small stones or rocks as it comes from the pit. Sharp,

2

clean, coarse sand, water washed, free from clay, salts and organic matter, and in accordance with CSA A179-93 for masonry sand is also acceptable.

3. Execution

3.1. INSTALLATION

- .1 All excavation and backfilling for all services shall be in accordance with Division 31, (the Site Work Division (Section 31 00 00.00 – EXCAVATION/EARTHWORKS)).
- .2 Refer to Section 31 23 00 (the Site Work Division (Section 31 00 00.00 – EXCAVATION/EARTHWORKS)) for rough excavation, removal of excavated material and backfill.
- .3 Protection:
 - .1 Provide protection to existing structures and services. Be responsible for rectifying any damage to existing structures and services resulting from this operation.
- .4 Excavation in Soil:
 - .1 Where rough excavation is carried out by Section 31 23 16.00, (Division 31), perform all layout work for trenches required under this Division, including verification of trench depths and slopes. Work in close cooperation with excavating trades that remove subgrade to within 6 in. (150 mm) of the correct and final trench depth
 - .2 Perform the final excavation to the correct trench invert to permit proper bedding as detailed in the Standard Drawings. Excavation carried below the correct inverts shall be backfilled with 2000 psi (13.5 mPa) concrete to the underside of the pipe lines, unless otherwise directed in writing.
- .5 Excavation in rock:
 - .1 All excavation in rock is included under separate Section, (in the Earth Work Division (Section 31 00 00.00 – EXCAVATION/EARTHWORKS)) and is taken to a minimum of 150 mm (6 in.) below the correct pipe invert. This Division shall use a bedding material as detailed in the Standard Drawings to the correct trench invert.
- .6 Backfilling
 - .1 Backfill with sand from the bottom of the trench or excavation up to a point 300 mm (12 in.) above the top of service line or appurtenance.
 - .2 Backfill pipe trenches with sand to a depth 300 mm (12 in.) above the pipe. The sand shall be thoroughly tamped around and over the pipes in 150 mm (6 in.) layers.
 - .3 Backfill up to top of subgrade.
 - .4 Backfill the remainder of trench or excavation up to top of subgrade or bottom of floor slabs on grade.

END OF SECTION

1 General

1.1 WORK INCLUDED

1.1.1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 RELATED WORK SPECIFIED ELSEWHERE

1.2.1 Firestopping and smoke seals within mechanical assemblies (i.e. inside ducts, dampers, etc.) with the exception of sleeves shown for future use installed in fire or smoke rated partitions shall be the responsibility of Mechanical Division. All other firestopping and smoke seals of mechanical services are part of Mechanical Division.

2 Products

2.1 MATERIALS

2.1.1 Sleeves passing through stud partitions shall be 0.75 mm (0.0299 in. -22 G.S.G.) steel.

2.1.2 Sleeves passing through concrete or masonry partitions shall be Schedule 40 steel pipe.

2.1.3 Sleeves passing through floors in finished areas and concealed spaces may be sheet metal or

2.1.4 Sleeves for pipes passing through exterior foundation walls shall be pre-manufactured molded non-metallic HDPE equal to PSI-Thunderline Model CS Century-Line. Each sleeve assembly shall have end caps manufactured of the same material as the sleeve and installed at each end to prevent deformation during the concrete pour.

2.1.4.1 The annular space between the service pipe and the sleeve shall be a modular EPDM seal element, reinforced nylon polymer pressure plates, joined with ASTM B633 carbon steel bolts with zinc dichromate and corrosion inhibiting coating equal to PSI- Thunderline Link-Seal Model C wall seal.

2.1.4.2 A reinforced concrete bridge shall be installed between the wall and the adjacent undisturbed soil.

2.1.5 Firestopping and smoke seal systems shall be in accordance with CAN4-S115 – Standard Method of Fire Tests for Firestop Systems, CAN/ULC-S101 – Standard Methods for Fire Endurance Tests of Building Construction and Materials, ASTM E119 – Standard Test Methods for Fire Tests of Building and Construction Materials, and ASTM E814 – Standard Test for Fire Tests of Through-Penetration Firestop Stops.

2.1.5.1 Unless noted otherwise “F” and “T” ratings are shown on the drawings.

- 2.1.5.2 Systems shall be asbestos free and maintain an effective barrier against flame, smoke, and gases in accordance with CAN4-S115 and shall not exceed opening sizes for which they are intended.
- 2.1.5.3 Firestopping and smoke seals at openings around mechanical services shall be an elastomeric seal for sound and vibration control.
- 2.1.5.4 Fire resistance rating of firestopping assembly shall not be less than the fire resistance rating of surrounding floor or wall assembly.
- 2.1.5.5 Service penetration assemblies shall be ULC certified in accordance with CAN4-S115 and listed in ULC Guide No. 40 U19.
- 2.1.5.6 Service penetration firestop components shall be ULC certified in accordance with CAN4-S115 and listed in ULC Guide No. 40 U19.13 and ULC Guide No. 40 U19.15.
- 2.1.6 Firestopping and smoke seals shall be by Hilti, Tremco/Royal Quickstop, or 3M.
- 2.1.7 Escutcheons shall be satin finish stainless steel or satin finish chrome or nickel plated brass, with non-ferrous set screws. Do not use stamped steel split plates. Split cast plates with screw locks may be used. For escutcheons for plumbing fixtures refer to Section 22 42 00.00
- 2.2 - FIXTURES AND TRIM.
 - 2.2.1 Provide adequate bracing for support of sleeves during concrete and masonry work. For floors and walls with a fire resistance rating, build fire damper assemblies into structure to attain fire rated construction, in a manner acceptable to the governing authorities.
 - 2.2.2 Cover exposed duct sleeves in finished areas with 1.42 mm (0.0561 in. - 18 G.S.G.) galvanized sheet steel in the form of duct collars. Fix in position with non-ferrous metal screws.
 - 2.2.3 Counter flashing for roof penetrations shall be commercial quality galvanized sheet steel to ASTM A653/A653M-02, 0.70 mm (0.0276 in. - 24 G.S.G.) minimum thickness, Z275 275 zinc coated by hot dip process.

3 Execution

3.1 INSTALLATION

- 3.1.1 Arrange for all chases and formed openings in walls and floors as required by the Mechanical Division for the mechanical services. These chases and openings shall not be larger than necessary to accommodate the equipment and services. Advise on these requirements well in advance, before the concrete is poured and the walls are built. All necessary sleeves and inserts shall be supplied by this Division.
- 3.1.2 Chases and openings not located in accordance with the above provisions shall be made at the expense of this Division. Cutting of structural members shall not be permitted without specified written acceptance of the Owner.

- 3.1.3 Provide sleeves for all service penetrations through walls, partitions, floorslabs, plenums and similar barriers.
- 3.1.4 Sleeves shall be sized to maintain insulation and vapour barrier around all pipes and ducts for all service penetrations. Coordinate thickness requirements with Section 21 07 00.00 – MECHANICAL INSULATION.
- 3.1.5 For sleeves through barriers without a fire resistance rating, for non-insulated pipe, fill the annular space between the service and the sleeve with fire rated insulation as specified in Section 21 07 00.00 – MECHANICAL INSULATION and caulk around the edges with smoke and acoustic sealant.
- 3.1.6 Firestopping and smoke seal material and components shall be installed in accordance with the ULC certification and manufacturers instructions. Examine the sizes and conditions of the cavities to be filled to determine the correct thicknesses and installation of materials. All substrates and surfaces in contact with firestopping materials shall be dry and prepared in accordance with the Manufacturers instructions at appropriate ambient conditions.
- 3.1.7 Where holes are core drilled in existing structures, sleeves shall be provided as specified complete with a combination puddle/anchor flange bolted to the floor. Seal watertight between the flange and the floor.
- 3.1.8 Provide escutcheons at all penetrations of piping into finished areas, and at insulated pipes, make the escutcheons large enough to fit around the insulation.
- 3.1.9 Counter flash vertical duct penetrations through roof at intersection of roof curb and duct.

END OF SECTION

1 General

1.1 WORK INCLUDED

- 1.1.1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.1.2 Openings required for mechanical services for new construction shall be in accordance with Section 21 05 83.00 – SLEEVES AND ESCUTCHEONS. This Section shall apply for openings required in existing construction or where sleeves for mechanical services have been omitted in new construction in error.
- 1.1.3 Include for all cutting and patching for all mechanical services for holes and openings with dimensions up to 200 mm (8 in.) in size and related patching. Carry out cutting and patching work in accordance with requirements of Section 01 60 00.00 – PROJECT FORMS.
- 1.1.4 Cutting and Patching shall be in accordance with Section 01 60 00.00 – PROJECT FORMS.

2 Products

2.1 MATERIALS

- 2.1.1 All services and materials used for the cutting and patching shall meet all requirements specified in Section 01 60 00.00 – PROJECT FORMS, and shall be carried out by professional workers experienced in the cutting and patching work to be done.

3 Execution

3.1 INSTALLATION

- 3.1.1 Locate all openings in non structural elements requiring cutting and patching in cooperation with Section 01 60 00.00 – PROJECT FORMS in a timely manner to avoid unnecessary cutting. All openings shall be shown on Drawings and submitted to the Owner for review. No holes through structure shall be permitted prior to review by the Structural Owner.
- 3.1.2 Core drilling for individual services shall be by this Division. Cut all openings no larger than is required for the services.
- 3.1.3 Locate all openings in structure elements requiring cutting and patching and x-ray the structure to obtain Structural Owner's approval prior to cutting or core drilling of existing structure. Make adjustments to location of openings as required to minimize cutting of rebar and completely avoid electrical conduit.
 - 3.1.3.1 Cut holes through slab only.
 - 3.1.3.2 Do not cut holes through beams.

- 3.1.3.3 Holes to be cut are 200 mm (8 in.) (diameter) or smaller only.
- 3.1.3.4 Maintain at least 100 mm (4 in.) clear from all beam faces. Space at least 3 hole diameters on Centre.
- 3.1.3.5 For holes that are required closer than 25% of slab span from the supporting beam face, use cover meter above the slab to clear slab top bars.
- 3.1.3.6 For holes that are required within 50% of slab span, use cover meter underside of slab to clear slab bottom bars.
- 3.1.3.7 X-rays shall be performed by a qualified technician, in a safe manner and in accordance with all applicable regulations governing this activity.
- 3.1.4 Obtain written approval from the Structural Owner before cutting or core drilling any openings or holes.
- 3.1.5 Patch all openings after services have been installed to match the surrounding finishes.

END OF SECTION

1. General

1.1. WORK INCLUDED

- .1 Conform to Section 15010 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Provide shop drawings with technical data on all types of insulation to be installed.
- .3 Provide two samples of each type of insulation indicating where each is to be used and a sample of a typical vapour barrier dam. Samples shall be mounted on boards. One shall be kept at the Contractor's site office and the other shall be turned over to the Owner.

2. Products

2.1. MATERIALS

- .1 Fibreglass insulation shall be Owens-Corning, Certainteed, Manson, Johns Manville, Knauf or Fibrex.
 - .1 Duct insulation shall be rigid board vapour seal 48 kg/cu.m. (3 lbs/cu.ft.) density duct insulation with factory applied vapour barrier. Flexible duct insulation shall be 24 kg/cu.m. (1-1/2 lbs/cu.ft.) type with vapour barrier.
 - .2 Pipe insulation shall be preformed sectional fibreglass or mineral fibre insulation with factory applied all service jacket.
 - .3 Insulation for linear radiant heating panels shall be 12 kg/cu.m. (3/4 lb.cu.ft.) density fibreglass batt insulation with foil back.
- .2 Flexible elastomeric insulation for ducts exterior to the building shall be Armacell with Tuffcoat 25 surface or Nomaco K-Flex with R-374 protective coating.
- .3 Extruded polystyrene insulation for ducts exterior to the building shall be Dow Weathermate Styrofoam insulation board.
- .4 Mineral Fibre Board Thermal insulation for ducts exterior to the building shall be Roxul RXL 80 125 kg/cu.m. (8 lbs/cu.ft.) density board insulation with factory applied reinforced foil vapour barrier.
- .5 Foamglass insulation shall be Pittsburgh-Corning.
- .6 Flexible elastomeric insulation shall be Armacell or Nomaco with adhesive applied to both surfaces to be joined. Flexible elastomeric insulation shall not be used on pipes that are electrically traced.
- .7 Insulation jacket for services and ductwork exterior to the building, and for indoor components such as valves, pump, meters, etc. shall be Childers or Armacell field applied U.V. protected mesh reinforced mastic.
 - .1 Mastic shall be equal to Childers VI-CRYL CP-10/11 weather barrier coating. Finish shall be white.
 - .2 Sealant for areas where mastic meets adjoining insulated or uninsulated surfaces or dissimilar weather proofing materials shall be equal to Childers CP-76.
 - .3 Glass fibre reinforcing mesh for thickness control and strength at joint interfaces in field

- applied mastic on exterior ductwork insulation shall be equal to Childers CHIL-GLAS # 10.
- .8 High temperature insulation shall be 232 kg/ cu.m. (14.5 lbs/cu.ft.) Johns Manville Thermo-12 Gold molded, asbestos free, non-combustible, abuse-resistant pipe and block insulation composed of hydrous calcium silicate meeting ASTM C533, Type I for operating temperatures up to 649 Deg. C. (1200 Deg. F.).
 - .1 Tie Wire shall be 16 gauge (0.045mm) stainless steel with twisted endons on maximum 300mm (12 in.) centres.
 - .9 High temperature insulation shall be Roxul SturdiRock molded, non-combustable, mineral wool fibre pipe insulation.
 - .10 Corner beads and channels at floor line shall be 0.4 mm (28 ga.) galvanized sheet metal.
 - .11 Fire retardant lagging coating shall be Chil-Seal CP-50 by Childers Products Company or Monsey Bakor equivalent.
 - .12 Vapour barrier dam shall be Chil-perm CP30 with fibreglass cloth reinforcing.
 - .13 All cements and adhesives shall be as recommended by the manufacturer of the insulation. Insulation, insulation jacket, canvas and adhesive shall be fire retardant with a flame spread rating not to exceed 25 and a smoke developed rating not to exceed 50 when tested in accordance with CAN/ULC-S102-M.
 - .14 P.V.C. fitted jackets and covers shall have a flame spread rating not to exceed 25 and a smoke developed rating not to exceed 50 when tested in accordance with CAN/ULC-S102-M.
 - .15 Aluminum Jacket shall be 0.51mm (24 B&S Gauge - 0.0201 in) this sheet, embossed finish, with longitudinal slip joints and 50mm (2 in.) laps, die shaped fitting covers with factory applied moisture barrier.
 - .16 Fire resistant duct insulation shall be Royal Quickstop Quickwrap, 3M Fire Barrier Duct Wrap, CL4Fire, or Unifrax Corporation FyreWrap to meet the requirements of NFPA 96. Product shall meet flame spread rating of 25 and smoke developed rating of 50. Insulation product shall be complete with all manufacturers standard fastenings, including (where applicable) aluminum foil tape, filament tape, banding materials, pins, cup-head weld pins, and speed clips for a ULC listed installation.

3. Execution

3.1. INSTALLATION

- .1 Install insulation in accordance with the manufacturer's printed installation instructions unless noted otherwise.
- .2 Insulation thicknesses and conductivities shall meet or exceed the minimum standards set out in ASHRAE 90.1 (refer to Table 1 following) and as specified herein for the services covered.
- .3 Apply insulation to clean, dry surfaces only while ambient temperature is at least 10 deg. C. (50 deg. F.).

- .4 Commence application of insulation following required testing of piping, ductwork, and apparatus where such items are to be covered.
- .5 Recover all insulation, where exposed to view and not concealed in ceiling spaces or pipe spaces with 6 oz. canvas pasted on. Apply two coats of fire retardant lagging finish.
- .6 Where approved by the Owner, as an alternative to the above, recover all piping insulation with a PVC jacket and preformed PVC elbows and fittings sealed with adhesive. PVC shall not be used on steam, medium and high temperature hot water piping or piping services that will be painted.
- .7 Cover all piping insulation external to the building and where specifically shown with field applied mesh reinforced mastic.
- .8 Where vapour barrier dams are called for, terminate the insulation and seal the vapour barrier to the pipe or ductwork using a mesh embedded in a vapour barrier mastic. Provide dams at valves, fittings used for servicing, groups of other types of fittings, irregular shaped objects at floor and wall penetrations, and at 15 m (50 ft.) intervals of straight pipe or straight ductwork for the following services: water piping that is less than 80 deg. F., including but not limited to the following:
 - .1 Domestic cold waterpiping
 - .2 and exterior ductwork
- .9 Terminate insulation on pipes passing through fire rated walls or floors, and fit tight to the fire stop material.
- .10 Irregular shaped objects such as strainers, pipe system filters, cyclone separators, blowdown valves and other accessories requiring servicing, on insulated piping, shall be insulated with removable caps or sections. All edges shall be sealed between pipe and vapour barrier and held in place with stainless steel straps. Finish all insulation smooth, making the outline of pipe insulation a true circular and concentric shape. Shape the outline of fitted insulation to blend with adjacent covering.
- .11 On piping systems specified to be insulated, include insulation on valves, flanges, couplings and unions.
- .12 Do not use staples to secure joints of insulation jackets.
- .13 Hot Services
 - .1 Heating water services, heating glycol and condensate piping shall have glass fibre preformed pipe insulation. Refer to Table 1 for required insulation thicknesses.
 - .2 On hot services, insulate valves, fittings, couplings, unions, flanges and all other appurtenances through which water or steam passes, using mitred sections of preformed insulation of a thickness equal to the adjoining pipe insulation, and securely wire in place. Over mitred section, apply one coat of field applied mesh reinforced mastic. Finish services with a vapour barrier using two full brush coats of vapour seal adhesive. Cover with canvas or PVC jacket.

- .3 Apply glass fibre or mineral fibre (RN to check) preformed vapour barrier jacket pipe insulation to domestic hot water piping. Refer to Table 1 following for required insulation thickness. Apply with all joints butted firmly together, and bond securely, sealing flaps by pasting down to give a smooth finish.
 - .4 Apply 50 mm (2 in.) thick mineral fiber tank wrap insulation (wired on) to the following:
 - .1 All domestic hot watertanks
 - .2 Heating water tanks
 - .3 Shell and tube heat exchangersRecover with canvas. Provide removable sections at access doors/manholes and all components requiring servicing.
 - .5 Insulate all hot gas piping in conditioned spaces with preformed glassfibre insulation. Cover exterior piping with field applied mesh reinforced mastic.
- .14 Cold Services
- .1 Protect insulation by means of sheet steel shields at each hanger or support on the following:
 - .1 Domestic cold water piping 75 mm (3 in.) and largerProvide foamglass, Thermo-12 or calcium silicate insulation inserts the full length of shields at all hangers and supports.
 - .2 For domestic cold water piping less than 75 mm (3 in.) where hangers on cold water lines penetrate vapour barrier make sure the penetration is properly sealed with insulation and vapour barrier continued up hanger a further 75 mm (3 in.).
 - .3 Where sheet metal shields are used refer to Section 15094 – HANGERS AND SUPPORTS.
 - .4 Apply 12 mm (1/2 in.) thick, preformed glass fibre pipe insulation with vapour barrier jacket or 12 mm (1/2 in.) thick flexible elastomeric insulation to all domestic cold water and chilled drinking water piping.
 - .5 On cold water service valves, water meters, drain valves, vent connections, thermometer wells, pressure gauges and other irregular shaped objects, apply flexible elastomeric sheet insulation, thickness to suit service, cut and mitre as necessary, and attach with adhesive and stainless steel banding. Bond and seal edges of insulation to the adjacent surfaces and finish with field applied mesh reinforced mastic.
- .15 Drainage Piping
- .1 Cover cast iron bell and spigot drainage pipe 75 mm (3 in.) and smaller with 12 mm (1/2 in.) preformed glass fibre pipe insulation, and finish with vapour barrier jacket. Cover the bell and spigot joint with a 12 mm (1/2 in.) thick flexible elastomeric insulation band that overlaps the fibreglass insulation 300 mm (12 in.) beyond joint in each direction. Seal band to the fibreglass insulation. Apply 25 mm (1 in.) thick insulation for all larger pipes.
 - .2 Storm Drainage piping to be insulated:
 - .1 Roof drain sump
 - .2 All horizontal or sloping storm piping
 - .3 All elbows connecting the horizontal storm drainage piping to the vertical leaders
 - .4 Where the roof drain is less than 3000 mm (10 ft.) from the vertical leader, insulate the first 3000 mm (10 ft.) of pipe closest to the roof drain and the exposed portion of the roof drain.

- .3 Sanitary drainage piping to be insulated:
 - .1 Sanitary drainage pipes from urinals
 - .2 Floor drains from air conditioning apparatus
 - .3 All piping passing through high humidity area
 - .4 Sanitary drainage pipe from barrier free lavatories
- .16 Ductwork and Equipment
 - .1 Ductwork and equipment internal to the building within conditioned spaces shall have 25 mm (1 in.) thick rigid glass fibre duct insulation with vapour barrier. In concealed spaces and on round duct smaller than 600 mm (24 in.) insulation may be 38mm (1-1/2 in.) flexible type with vapour barrier. Flexible duct connections do not require insulation except where a factory applied insulation has been specified with the flexible duct connection.
 - .2 Butt join insulation and attach with pins and speed washers, one per 0.186 sq.m. (2 sq.ft.), but not more than 450 mm (18 in.) apart in any direction. Apply fire resistive adhesive in 100 mm (4 in.) wide strips on 300 mm (12 in.) centres. Seal all joints with adhesive and apply vapour barrier tape. Install pins of suitable length for the thickness of insulation and clip flush after final installation of washers. Tack weld pins to sheet metal.
 - .3 On exposed insulation in mechanical rooms, increase thickness as necessary to give 12 mm (1/2 in.) thickness over flanges and angles. Provide corner beads to protect corners to a height of 2135 mm (84 in.) above floor and provide channels at floor line to finish off insulation on apparatus.

- .4 Insulation Contractor to coordinate with sheet metal contractor to ensure duct insulation is applied prior to ductwork being installed to underside of slabs, beams or other services or behind other duct risers and shafts.
- .17 The following ductwork and equipment shall be insulated:
 - .1 Apparatus casings
 - .2 Outside and mixed air plenums
 - .3 Outside and mixed air ductwork, including ducts to and from independent ERVs
 - .4 Heating and cooling coil sections of ductwork and plenums
 - .5 Supply ductwork in equipment rooms.
 - .6 Exhaust and relief air ductwork. Plenums and/or casings from 1500 mm (60 in.) upstream of shut-off dampers to connection to exterior wall or roof
 - .7 Exhaust, relief and supply and return air ductwork, plenums and/or casings through non-air conditioned or unheated internal space. Use 50 mm (2 in.) thickness.
 - .8 For LEED projects, all supply air ductwork (variable volume or constant volume systems) from fans to any terminal grille or diffuser.
 - .9 Silencers and fan capacity monitors. Insulate to suit the service and location.
- .18 Radiant heating panel. Install 50 mm (2 in.) fibreglass batt insulation with foil back above all active linear radiant heating panels.

.19 TABLE 1: MINIMUM PIPE INSULATION THICKNESS/PERFORMANCE (BASED ON ASHRAE 90.1 AND NATIONAL ENERGY CODE FOR BUILDINGS)

Fluid Design		Insulation Conductivity		Nominal Pipe Diameter – mm (in)				
Operating	Conductivity	Mean	Runouts ^b	25 (1)	32-50	65-100	125-150	200 (8)
Temp. range	y	Rating	Up to 50	and less	(1-1/4 to	(2-1/2 to	(5-6)	and up
[°C]	[W(m-K)]	Temp	(2)		2)	4)		
(°F)	(h-ft ² -°F	°C						
	(Btu-in)	[°F]						
Heating Systems (Steam, Steam Condensate, Heating Glycol and Heating Water)								
Above 177	0.049	121	38	65	65	75	87	87
Above (350)	(0.34)	(250)	(1.5)	(2.5)	(2.5)	(3.0)	(3.5)	(3.5)
122-177	0.045	93	38	50	65	65	87	87
(251-350)	(0.31)	(200)	(1.5)	(2.0)	(2.5)	(2.5)	(3.5)	(3.5)
94-121	0.043	66	25	38	38	50	50	87
(201-250)	(0.30)	(150)	(1.0)	(1.5)	(1.5)	(2.0)	(2.0)	(3.5)
61-93	0.042	52	25	25	25	38	38	38
(141-200)	(0.29)	(125)	(1.0)	(1.0)	(1.0)	(1.5)	(1.5)	(1.5)
41-60	0.040	38	25	25	25	25	38	38
(105-140)	(0.28)	(100)	(1.0)	(1.0)	(1.0)	(1.0)	(1.5)	(1.5)
Domestic and Service Hot Water Systems ^c								
41 and								
greater	0.040	38	25	25	25	38	38	38
(105) and								
greater	(0.28)	(100)	(1.0)	(1.0)	(1.0)	(1.5)	(1.5)	(1.5)

^a Piping installed exterior to the building shall meet the minimum insulation requirements of Heating Systems with a fluid design operating temperature above 177 Deg. C. (350 Deg. F.).

^b Runouts to individual terminal units not exceeding 3.7 m (12 ft.) in length

^c Applies to recirculating sections of service or domestic hot water systems and first 2.4 m (8 ft.) from storage tank for non-recirculating systems.

END OF SECTION

1. General

1.1. WORK INCLUDED

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Conform to Section 21 05 02.00 – RECORD DRAWINGS.
- .3 Conform to Section 21 05 03.00 – SHOP DRAWINGS.
- .4 Conform to Section 21 08 03.00 – OPERATING AND MAINTENANCE INSTRUCTIONS.
- .5 Conform to Section 23 05 93.13 – TESTING AND BALANCING OF PIPING SYSTEMS.
- .6 Conform to Section 23 05 93.23 – TESTING AND BALANCING OF AIR SYSTEMS.
- .7 Conform to Section 23 09 00.00 – BUILDING AUTOMATION SYSTEM.
- .8 The commissioning process for the Mechanical Systems shall include:
 - .1 Verification that the installation meets the requirements of the contract documents.
 - .2 Verification that the systems performance meets the design intent.
 - .3 Provision of building operator training.
 - .4 Provision of as-built documentation, operating and maintenance manuals, and systems operating manuals.
- .9 The Contractor, Owner and Commissioning Agent shall provide the services to complete the process. The execution portion of this Section defines the areas of responsibility.
- .10 Provide labour, equipment and material to conduct the Contractor commissioning process as outlined in this Section.
- .11 The Owner will hire a Commissioning Agent who will provide services identified in the article within this Section.
- .12 An Independent Testing and Balancing Contractor will provide the services identified in the Sections for "Testing and Balancing of Water and Air Systems".

2. Products

2.1. MATERIALS

- .1 The Contractor and manufacturers shall provide all instrumentation and equipment necessary to conduct the tests as specified in the Mechanical Sections. The Contractor shall advise the Owners or Commissioning Agent of instrumentation to be used and the dates the instruments were calibrated.

3. Execution

3.1. INSTALLATION

- .1 This Section describes the commissioning process to be performed by the Contractor. The process shall provide a high level of quality control during the construction.
 - .2 The commissioning process shall consist of:
 - .1 Shop Drawings/Record Drawings
 - .2 Installation inspection and equipment verification
 - .3 Plumbing and drainage system testing
 - .4 Testing of piping systems
 - .5 Independent Contractor balancing of water systems
 - .6 Testing of air systems
 - .7 Independent Contractor balancing of air systems
 - .8 Testing of equipment and systems
 - .9 Building Automation System Commissioning
 - .10 Commissioning Agent performance testing
 - .11 Commissioning meetings
 - .12 Operating and maintenance manuals
 - .13 Training
 - .14 Systems acceptance

3.2. INSTALLATION INSPECTION AND EQUIPMENT VERIFICATION

- .1 The Contractor shall complete the equipment verification forms for each piece of equipment. The completed forms shall be forwarded to the Owner for review and be included in the operating and maintenance manual.

3.3. TEST FORMS AND VERIFICATION FORMS

- .1 The Commissioning Agent will prepare a test form manual, which will contain a form for every test identified in the Specification. A copy of this manual will be given to the Contractor, the General Contractor and the Owner.
- .2 The forms shall be signed by either the authorities, the Owner or the Commissioning Agent.
- .3 Test forms and verification forms have been included with this Section. Obtain approval from the Owner if the Contractor wishes to use different forms.

3.4. PLUMBING AND DRAINAGE SYSTEM TESTING

- .1 The plumbing and drainage system shall be tested in accordance with Section 23 05 93.13.
- .2 The Contractor shall notify the Building Inspector when systems are available for testing. The Contractor shall document all tests performed and shall arrange for the Building Inspector to sign the forms for tests completed.

3.5. TESTING OF PIPINGSYSTEMS

- .1 Test all piping systems in accordance with Section 23 05 93.13 - TESTING AND BALANCING PIPING SYSTEMS.
- .2 All tests for the systems shall be performed in the presence of the Owner or the Commissioning Agent.

3.6. TESTING OF AIR SYSTEMS

- .1 Conform with Section 23 05 93.23 – TESTING AND BALANCING AIR SYSTEMS.
- .2 All tests shall be performed in the presence of the Owner or the Commissioning Agent.

3.7. TESTING OF EQUIPMENT AND SYSTEMS

- .1 Conform to Section 21 08 03.00 – OPERATING AND MAINTENANCE INSTRUCTIONS
- .2 The Contractor shall hire the services of the manufacturers technicians to test the equipment and associated systems. The technician shall record the results of the tests on the testing forms. The tests shall be witnessed by the Owner or the Commissioning Agent. When the tests have been completed satisfactorily the technician and witnessing authority shall sign the forms.
- .3 Should equipment or systems fail a test, the test shall be repeated after repairs or adjustments have been made. The additional tests shall be witnessed by the Owner or the Commissioning Agent.
- .4 Tests which have not been witnessed shall not be accepted and shall be repeated.

3.8. COMMISSIONING MEETINGS AND SCHEDULING

- .1 The Contractor shall include the schedule for all tests and equipment start-up tests in the construction schedule.
- .2 The commissioning meetings shall occur during the regular construction meetings. The testing schedules and results of all tests shall be reviewed.

3.9. OPERATING AND MAINTENANCE MANUALS

- .1 Conform to Section 21 08 03.00 – OPERATING AND MAINTENANCE INSTRUCTIONS.
- .2 Submit Operating and Maintenance Manuals to Commissioning Agent for review.

3.10. OPERATOR TRAINING

- .1 Conform to Section 21 08 03.00 – OPERATING AND MAINTENANCE INSTRUCTIONS.
- .2 Submit Operating and Maintenance manuals to Commissioning Agent for review.

- .3 The training shall be conducted in a classroom and at the equipment or system.
- .4 Training will begin when the operating and maintenance manuals have been delivered to the Owner and reviewed by the Owner.
- .5 Submit a course outline to the Owner before training commences. Provide course documentation for up to eight people.
- .6 Each training session will be structured to cover:
 - .1 The operating and maintenance manual
 - .2 Operating procedures
 - .3 Maintenance procedures
 - .4 Trouble-shooting procedures
 - .5 Spare parts required
- .7 The training sessions will be scheduled and co-ordinated by the Commissioning Agent. The Commissioning Agent will video tape the session.
- .8 Training shall be provided for the following systems:

System	Minimum Training Times
Boilers	3 hours
Life safety & fire protection systems	3 hours
Building Automation System	8 hours
The mechanical system	16 hours
- .9 Refer to Section 23 09 00.00 – BUILDING AUTOMATION SYSTEMS.
- .10 The training requirement for the mechanical system shall include a walk-through of the building by the Contractor. During the walk through the Contractor shall:
 - .1 Identify equipment
 - .2 Identify starters associated with equipment
 - .3 Identify valves and balancing dampers
 - .4 Identify access doors
 - .5 Review general maintenance of equipment
 - .6 Review drain locations in pipework systems
 - .7 Identify maintenance items
- .11 When each training session has been completed with the Owners representative, the Commissioning Agent will sign the associated form to verify completion.

3.11. COMMISSIONING AGENT

- .1 A Commissioning Agent will be hired by the Owner.
- .2 The Commissioning Agent responsibilities shall include:
 - .1 Preparing the commissioning plan
 - .2 Coordinating with the Contractor to schedule tests
 - .3 Preparing a test form manual
 - .4 Witnessing selected tests
 - .5 Receiving all test forms
 - .6 Conducting performance test
 - .7 Coordinating the Contractors training
 - .8 Attend commissioning meetings
 - .9 Preparing the systems operating manuals
- .3 The Contractor shall co-ordinate and co-operate with the Commissioning Agent.

3.12. PERFORMANCE TESTING

- .1 The Commissioning Agent will conduct performance tests on each mechanical system to verify that the design intent performance has been met. The performance tests will cover all seasonal modes. The Commissioning Agent will visit the building in six months to retest the systems.
- .2 The Contractor shall provide assistance to the Commissioning Agent and have personnel available during the performance testing procedures during construction and the warranty period.
- .3 Performance testing will begin when all mechanical systems have been completed, tested by the Contractor reviewed by the Owner and substantial completion has been achieved.

3.13. COMMISSIONING PROCESS ALLOCATION

- .1 The commissioning process shall be allocated a value equal to 8% of the contract. This value shall be itemized in the Statement of Prices which forms the basis for progress payment for the various portions of work. The Contractors may draw from this allocation as the commissioning process is completed.
 - .1 The Contractors shall submit all test and verification forms. The Owner will use these forms to calculate a percentage complete.
 - .2 The Contractor may claim up to 5% of the contract, as per Schedule of Breakdown, on a monthly basis, from this allocation leading up to performance testing. The remaining 3% shall not be paid out until the performance testing, O&M manuals and training have been completed satisfactorily.
- The commissioning process allocation shall be broken down as follows:
- | | |
|---|-------|
| .1 Shop Drawings | 0.50% |
| .2 Installation inspection and equipment verification | 0.50% |
| .3 Plumbing and drainage system testing | 0.50% |

.4	Testing of piping systems	0.50%
.5	Independent Contractor balancing of water systems	0.25%
.6	Testing of air systems	0.50%
.7	Independent Contractor balancing of air systems	0.25%
.8	Testing of equipment and systems (system start-up)	0.50%
.9	BAS commissioning	1.00%
.10	Commissioning Agent Performance Testing	2.00%
.11	Operating and Maintenance Manuals	0.50%
.12	Training	0.50%
.13	Record Drawings	0.50%

END OF SECTION

1. General

1.1. WORK INCLUDED

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

NOT USED

3. Execution

3.1. INSTALLATION

- .1 Clean thoroughly all fixtures and equipment from grease, dirt, plaster or any other foreign material. Chrome-plated fittings, piping and trim shall be polished upon completion.
- .2 Any dirt, rubbish, or grease on walls, floors or fixtures accumulated from the work of the Mechanical Division shall be removed promptly from the premises by this Division.
- .3 Fixtures and equipment shall be properly protected from damage during the construction period and shall be cleaned and polished in accordance with manufacturer's directions. Motors and equipment bearings shall be protected with plastic sheets, tied or taped in place. Aluminum fin heating or cooling elements shall be protected with cardboard covers.
- .4 Any unpainted steel surfaces, installed for longer than one year prior to the completion date, shall be prime coated under this Division.
- .5 During construction protect all services and equipment from dirt and debris, by using temporary caps over the open ends of pipes ductwork and equipment connections.
- .6 All equipment installed or stored on site shall be maintained in accordance with manufacturers recommended instructions (i.e. rotate shafts on fans, pumps, etc).
- .7 Refinish and restore to the original condition and appearance all mechanical equipment which has sustained damage to the manufacturer's prime and finish coats of enamel or paint. Materials and workmanship shall be equal to the manufacturers original.

END OF SECTION

1. General

1.1. WORK INCLUDED

- .1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- .2 Comply with all requirements of Section 21 05 02.00 – RECORD DRAWINGS.
- .3 Comply with all requirements of Section 21 05 03.00 – SHOP DRAWINGS.
- .4 Comply with all requirements of Section 21 08 00.00 – COMMISSIONING.
- .5 Comply with all requirements of Section 01 78 00 – CLOSEOUT SUBMITTALS.

2. Products

2.1. REQUIREMENTS FOR MANUALS

- .1 Three copies of complete and approved operating and maintenance instructions for all mechanical equipment and systems shall be supplied before substantial completion. Manuals shall be also submitted in electronic format. Electronic manuals shall be prepared in Adobe PDF format with all sections bookmarked for quick reference and submitted on DVD.
- .2 Binders shall be three-ring, hard-cover, loose-leaf type and identified on the binding edges as "Maintenance Instructions and Data Book", for this project.
- .3 Terminology used in all the Sections shall be consistent.
- .4 Volume One shall contain the master index of all systems, the name of the Contractor, Mechanical Sub-Contractors and the date of substantial performance for the Contract.
- .5 Volume One shall contain a section with all necessary warranty information.
- .6 Each binder shall have a complete index for all volumes.
- .7 Each binder shall be no more than half filled.
- .8 There shall be a separate section for all materials used on the project which fall under the WHMIS legislation. There shall be a hazard data sheet for each of the materials.
- .9 There shall be a separate section for all Insurance Certificates, Test Certificates, Verification Forms and Test Forms.
- .10 All relevant information relating to a system or product shall be contained within one binder.
- .11 The manual sections shall follow the specification sections.
- .12 Any diagrams, installation drawings, flow charts, etc. shall be mechanically reduced while

maintaining full legibility to standard page size. If this cannot be achieved they shall be carefully folded and contained within a clear plastic wallet within the manual.

2.2. DATA FOR MANUALS

- .1 Equipment data shall contain:
 - .1 Operating instructions
 - .2 Operating conditions such as temperature and pressure
 - .3 Location of equipment
 - .4 Maintenance instructions and schedules for one year routine
 - .5 Recommended list of spare parts
 - .6 Lubrication schedule
 - .7 A trouble shooting table showing where to look for problems under various conditions of malfunction
 - .8 All wiring diagrams
 - .9 Equipment operating curves
 - .10 Equipment nameplate data and serial numbers
- .2 System data shall contain:
 - .1 A listing of all systems
 - .2 A valve schedule and locations
 - .3 Equipment name tags
 - .4 Filter schedule
 - .5 An electric pipe tracing schedule including location and electrical service location
 - .6 Cleaning, maintaining and preserving instructions for all material, products and surfaces. Include warnings of harmful cleaning, maintaining and preserving practices.
- .3 Sub-Contractor manuals are required for:
 - .1 BAS
 - .2 Water treatment
 - .3 Water and air balancing
- .4 As-built documentation shall contain:
 - .1 Reviewed As-Built Shop Drawings
 - .2 As-Built Construction Drawings
 - .3 Originals of Test Forms
 - .4 Originals of Test Certificates

2.3. ASSET SPREADSHEET

- .1 The Mechanical Contractor shall provide the following information on an excel spreadsheet to be provided by the Landlord:

- .1 Asset Name
 - .2 Manufacturer
 - .3 Model Number
 - .4 Serial Number.
- .2 The above information shall be provided for the following mechanical equipment:
- .1 boilers and boiler burners
 - .2 domestic water heaters
 - .3 forced flow units
 - .4 heat exchangers
 - .5 fans
 - .6 pumps
 - .7 tanks
 - .8 meters

2.4. OPERATING INSTRUCTIONS

- .1 Instruct the Owner's representative in all aspects of the operation and maintenance of systems and equipment.
- .2 Comply with all requirements of Section 21 08 00.00 – COMMISSIONING, for duration of tests.
- .3 Instruct the Owner for a minimum of five (5) working days.
- .4 Arrange for and pay for the services of engineers and other manufacturers representatives required for instruction on the systems and the equipment as requested by the Owner and/or the Owner.
- .5 At the time of final inspection, provide a sheet for each system and piece of equipment showing the date instructions were given. Each sheet shall show the duration of instruction, name of persons receiving instruction, other persons present (manufacturer's representative, Owner, etc.), system or equipment involved and signature of the Owner's staff stating that they understood the system installation, operating and maintenance requirements. This information shall be inserted in the manuals after all instructions have been completed.
- .6 Review information with the Owner's representative to ensure that all information required has been provided.

- .7 Mechanical equipment and systems included in the instruction requirements are:
 - .1 Heating water generators and associated equipment
 - .2 Automatic controls and instrumentation
 - .3 Water treatment and cleaning
 - .4 Life safety and fire protection
 - .5 Noise and vibration
 - .6 Condenser water distribution system
 - .7 Heating water distribution systems
 - .8 Air handling distribution and components
 - .9 Miscellaneous ventilation systems
 - .10 Storm, sanitary and domestic water pumping and distribution system

2.5. TRIAL USAGE

- .1 The Owner shall be permitted trial usage of systems or parts of systems for the purpose of testing and learning operational procedures. Trial usage shall not affect the warranties nor be construed as acceptance, and no claim for damage shall be made against the Owner for any injury or breakage to any part or parts due to the tests, where such injuries or breakage are caused by a weakness or inadequacy of parts, or by defective materials or workmanship of any kind.

3. Execution

NOT USED

END OF SECTION

1. GENERAL

1.1 RELATED REQUIREMENTS

1.1.1 Section 23 01 10 - Mechanical General Provisions.

1.1.2 Section 23 01 20 - Mechanical Submittals.

1.2 REFERENCES

1.2.1 ANSI/NFPA 10-1988, Portable Fire Extinguishers.

1.2.2 CAN4-S508-M83, Rating and Fire Testing of Fire Extinguishers.

1.3 SHOP DRAWINGS AND PRODUCT DATA

1.3.1 Submit shop drawings and product data in accordance with Section 23 01 20- Mechanical Submittals.

1.4 MAINTENANCE DATA

1.4.1 Provide maintenance data for incorporation into manual specified in Section 23 01 20 - Mechanical Submittals.

2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

2.1.1 Extinguishers: Ansul, Flag, Kidd, Pyrene, Pyro-Chem.

2.1.2 Fire Extinguisher Cabinets: CFH Industries, Impaction Fire quip Inc., National Fire Equipment, Wholesale Fire and Rescue Ltd.

2.2 MULTI-PURPOSE DRY CHEMICAL EXTINGUISHERS (FOR GENERAL USE)

2.2.1 Stored pressure rechargeable type with hose and shut-off nozzle, ULC labeled for A, B and C class protection. Size 4.5 kg or as indicated.

2.3 BICARBONATE EXTINGUISHERS (FOR HOME EC. & FOOD TYPE AREAS)

2.3.1 Stored pressure rechargeable type with hose and shut-off nozzle, ULC labeled for bicarbonate. Sizes 4.5 kg.

2.4 CARBON DIOXIDE EXTINGUISHERS (FOR COMPUTER AREAS)

2.4.1 Insulated handle, hose and horn discharge assembly, self-closing lever or squeeze-grip operation, fully charged, ULC labeled for B and C class protection. Sizes 4.5 kg.

2.5 EXTINGUISHER BRACKETS

- 2.5.1 Type recommended by extinguisher manufacturer, provide bracket inside each cabinet.

2.6 CABINETS

- 2.6.1 Semi - recessed cabinet.

- 2.6.1.1 Cabinet Constructed of 1.6 mm thick steel with 100 mm recess adjustable front and a 50 mm turnback., 180 degree opening door of 2.5 mm thick steel with latching device.

- 2.6.1.2 Cabinet to maintain fire resistive rating of construction in which it occurs.

- 2.6.1.3 Cabinet door: with 6mm georgian glass panel.

- 2.6.1.4 Finish:

- 2.6.1.4.1 Tub: prime coat

- 2.6.1.4.2 Door and Frame: No. 4 brushed stainless steel.

- 2.6.1.5 Acceptable material: WFR model FEC - 1.

- 2.6.1.5.1

2.7 IDENTIFICATION

- 2.7.1 Identify extinguishers in accordance with recommendations of ANSI/NFPA 10.

- 2.7.2 Attach bilingual tag or label to extinguishers, indicating month and year of installation. Provide space for service dates.

3 EXECUTION

3.1 INSTALLATION

- 3.1.1 Install or mount extinguishers in cabinets or on brackets as indicated.

- 3.1.2 Mounting height to be 1500 mm to the top of the cabinet or bracket.

END OF SECTION

1 GENERAL

1.1 RELATED REQUIREMENTS

- 1.1.1 Section 23 01 10: Mechanical General Provisions.
- 1.1.2 Section 23 01 20: Mechanical Submittals.
- 1.1.3 Section 22 42 01: Plumbing Fixtures and Trim.
- 1.1.4 Section 07 84 00: Fire Stopping

1.2 REFERENCE STANDARDS

- 1.2.1 Do plumbing specialties and accessories work in accordance with BC Plumbing Code and local authority having jurisdiction except where specified otherwise.

1.3 SHOP DRAWINGS

- 1.3.1 Submit shop drawings in accordance with Section 23 01 20 - Mechanical Submittals.
- 1.3.2 Submit product data in accordance with Division one
- 1.3.3 Indicate dimensions, construction details and materials for all equipment.

2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- 2.1.1 Floor Drains: Ancon, Jay R. Smith, Zurn
- 2.1.2 Cleanouts: Ancon, Jay R. Smith, Zurn
- 2.1.3 Water hammer Arrestors: Amtrol, Ancon, Roto-Tech Smith, Wade, Zurn
- 2.1.4 Back Flow Preventors: Watts, Conbraco, Febco.
- 2.1.5 Hose Bibbs: Emco, Crane, Waltec, Cambridge Brass
- 2.1.6 Water Make up Assembly: Taco, Watts, Armstrong
- 2.1.7 Trap Seal Primers: Ancon, Jay R. Smith, Zurn , Crane
- 2.1.8 Strainers: Armstrong, Braukmann, Crane, Leitch, Toyo
- 2.1.9 Sediment Interceptor: Watts, Zurn

2.2 FLOOR DRAINS

- 2.2.1 Type I: (general use) cast iron body round, adjustable head, nickel bronze strainer,

integral seepage pan, and clamping collar, primer tapping.

2.2.1.1 Acceptable Material: Watts FD-100-C.

2.2.2 Type II: (combination funnel floor drain) cast iron body with integral seepage pan, clamping collar, nickel-bronze adjustable head strainer with integral funnel.

2.2.2.1 Acceptable Material: Watts FD-100-C-EG.

2.2.3 Note, floor drains with trap primers are to be put in only where required by code.

2.3 CLEANOUTS

2.3.1 Cleanout plugs (cast iron): heavy CI male ferrule with brass screws and threaded brass or bronze plug. Sealing-caulked lead seat or neoprene gasket.

2.3.1.1 Acceptable Materials: Watts CO-100-C-R.

2.3.2 Access covers:

2.3.2.1 Wall access: Standard access door and/or face or wall type, stainless steel with flush head securing screws.

2.3.2.1.1 Acceptable Materials: Watts.

2.3.2.2 Floor access: (cleanout) round cast box with anchor lugs and:

2.3.2.2.1 Plugs: bolted bronze with neoprene gasket.

2.3.2.2.2 Cover for unfinished concrete floors: nickel bronze round or square, gasket, vandal-proof screws.

- Acceptable Materials: Watts CO-100-C-R.

2.3.2.2.3 Cover for terrazo finish: polished brass with recessed cover for filling with terrazo, vandal-proof locking screw.

- Acceptable Materials: WattsCO-100-C-U-1.
- 2.4.2.2.4 Cover for tile and linoleum floors: polished brass with recessed cover for linoleum or tile infill, complete with vandal-proof locking screws:
 - Acceptable Materials: WattsCO-100-C-T-1.
- 2.4.2.2.5 Cover for carpeted floors: polished brass with deep flange cover for carpet infill, complete with carpet markerscrew.
 - Acceptable Materials: WattsCO-100-RC-1.
- 2.4 HYDRANTS
 - 2.5.1 Concealed non-freeze wall hydrant with NPS 19mm hose outlet. Removable operating key and vacuum breaker. Chrome finish.
 - 2.5.2 Acceptable Materials: Watts HY-725-CR.
- 2.6 WATER HAMMER ARRESTORS
 - 2.6.1 Stainless steel construction, piston type only: to Plumbing and Drainage Institute Standard PDI-WH 201-77.
- 2.7 BACK FLOW PREVENTERS
 - 2.7.1 Protect entire potable water distribution system against contamination due to back flow from non-potable sources as indicated and as required by applicable plumbing codes and local authorities. Back flow preventer, reduced pressure principle type: to CSA B64.10-M1981.
- 2.8 HOSE BIBBS
 - 2.8.1 Bronze construction complete with hose thread spout replaceable composition disc, and chrome plated in finished areas.
 - 2.8.2 Acceptable Materials: Crane C5046
- 2.9 WATER MAKE-UP ASSEMBLY
 - 2.9.1 Pressure reducing valve type complete with integral strainer, gate valve, pressure gauges between inlet and outlet and pressure relief valve on reduced pressure side.
 - 2.9.2 Acceptable Materials: Taco 323 and 327
- 2.10 STRAINERS
 - 2.10.1 860 kPa gauge pressure Y type strainer with 20 mesh, monel, bronze or stainless steel removable screen.
 - 2.10.2 50 mm nominal and under, bronze, and screwed with brass cap.

2.10.2.1 Acceptable Materials: Crane 988 -2

2.10.3 65 mm nominal and over, cast iron, flanged with bolted cap.

2.10.3.1 Acceptable Materials: Crane 989 –2

2.10.3.1.12.12

2.10.3.1.

2.11

TRAPS

2.11.1 Cast iron body deep seal traps, threaded, hub, or spigot on inlet.

2.12 SEDIMENT INTERCEPTOR

2.12.1 Solids and sediments interceptor shall be recessed, epoxy coated steel solids interceptor with gasketed epoxy coated steel skid-proof cover secured with hex head center bolt(s), removable sediment basket, and no hub connection.

2.13 FIRE STOPPING

2.13.1 Fire stopping related to mechanical installation shall be the responsibility of the mechanical contractor. Refer to section 07 84 00 for product requirement. Fire stopping contractor shall be ULC approved.

3 EXECUTION

3.1 CLEANOUTS

- 3.1.1 In addition to those required by code, install at base of all soil and waste stacks, and rainwater leaders and where indicated.
- 3.1.2 Bring cleanouts to wall or finished floor unless serviceable from below floor.
- 3.1.3 Building drain cleanout and stack base cleanouts: line size to maximum NPS 4.

3.2 HYDRANTS

- 3.2.1 Install non freeze wall hydrant 600 mm above finished grade unless otherwise indicated.

3.3 WATER HAMMER ARRESTORS

- 3.3.1 Install on branch supplies to each fixture or group of fixtures and where indicated.

3.4 BACK FLOW PREVENTION

- 3.4.1 Install approved type of back flow prevention device, and or vacuum breaker in accordance with manufacturers instructions, as indicated and as required by applicable plumbing codes and local authorities to protect entire potable water system against contamination due to backflow from non-potable sources. Install generally on the following; make-up water on boilers, and glycol systems; plumbing systems, fire protection water, and all equipment connected to domestic water sources requiring protection.
- 3.4.2 Pipe discharge to nearest drain.
- 3.4.3 The following Table I and Table II indicates the acceptable devices for specific equipment:

TABLE I
INTERNAL BUILDING PROTECTION

<u>Description of Cross Connection</u>	<u>Protection of Fixture</u>	<u>Additional Premise Isolation</u>
* Connection to Sewer Pipe	AG	
* Heating and Cooling System with Chemical Additives	RP	
* Heating Equipment	DCVA	
* Hose Bibbs	AVB or HCVB	
* Other Equipment	AVB	

Backflow Control - Devices

Air Gap (AG)

Reduced Pressure Principle Backflow Prevention
Assembly (RP)

Double Check Valve Assembly (DCVA)

Pressure Vacuum Breaker (PVB)

Atmospheric Vacuum Breaker (AVB)

Hose Connection Vacuum Breaker (HCVB)

Laboratory Faucet Vacuum Breaker (LFVB)

Dual Check with Atmospheric Port (DCAP)

Dual Check Valve (DuC)

3.5 HOSE BIBBS

3.5.1 Install at bottom of all risers, at low points to drain systems, and as indicated and under sinks in washrooms.

3.6 WATER MAKE-UP ASSEMBLY

3.6.1 Install in accordance with manufacturers instructions. Provide on hot water heating systems, glycol heating systems and as indicated.

3.6.2 Pipe relief valve to nearest drain.

3.7 TRAP SEAL PRIMERS

3.7.1 Install on floor drains only as required by code.

3.8 STRAINERS

3.8.1 Install in accordance with manufacturers' instructions. Allow sufficient room to remove basket.

3.9 FIRE STOPPING

3.9.1 Fire stopping related to mechanical installation shall be the responsibility of the mechanical contractor. Refer to section 07 84 00 for installation requirement. Fire stopping contractor shall be ULC approved.

END OF SECTION

1 GENERAL

1.1 REFERENCED SECTIONS

- 1.1.1 Section 23 01 10 - Mechanical General Provisions.
- 1.1.2 Section 23 05 23 - Valves
- 1.1.3 Section 23 05 93 - Testing, Adjusting and Balancing (TAB) of Mechanical Systems.

1.2 REFERENCES

- 1.2.1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - 1.2.1.1 ANSI/ASME B16.15-85(R1994), Cast Bronze Threaded Fittings, Classes 125 and 250.
 - 1.2.1.2 ANSI/ASME B16.18-84(R1994), Cast Copper Alloy Solder Joint Pressure Fittings.
 - 1.2.1.3 ANSI/ASME B16.22-95, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
 - 1.2.1.4 ANSI/ASME B16.24-91, Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150 and 300.
- 1.2.2 American Society for Testing and Materials (ASTM)
 - 1.2.2.1 ASTM A307-00, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
 - 1.2.2.2 ASTM B88M-99, Specification for Seamless Copper Water Tube (Metric).
 - 1.2.2.3 ASTM F492-95, Specification for Propylene and Polypropylene (PP) Plastic-Lined Ferrous Metal Pipe and Fittings.
- 1.2.3 American Water Works Association (AWWA)
 - 1.2.3.1 .1 ANSI/AWWA C111/A21.11-00, Rubber Gasket Joints for Ductile-Iron and Fittings.
- 1.2.4 Manufacturer's Standardization of the Valve and Fittings Industry (MSS)
 - 1.2.4.1 MSS-SP-67-95, Butterfly Valves.
 - 1.2.4.2 MSS-SP-70-98, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - 1.2.4.3 MSS-SP-71-97, Cast Iron Swing Check Valves Flanged and Threaded Ends.
 - 1.2.4.4 MSS-SP-80-97, Bronze Gate, Globe, Angle and Check Valves.

1.3 SUBMITTALS

- 1.3.1 Submit test reports in accordance with Section 23 01 10.

- 1.3.2 Provide maintenance data for incorporation into manual specified in Section 15010.

2 PRODUCTS

2.1 PIPING

- 2.1.1 Domestic hot, cold and recirculation systems, within building.

- 2.1.1.1 Above ground: copper tube, hard drawn, type L: to ASTM B88M.
 - 2.1.1.2 Buried or embedded: copper tube, soft annealed, type K: to ASTM B88M, in long lengths and with no buried joints.

2.2 FITTINGS

- 2.2.1 Bronze pipe flanges and flanged fittings, Class 150 and 300: to ANSI/ASME B16.24.
- 2.2.2 Cast bronze threaded fittings, Class 125 and 250: to ANSI/ASME B16.15.
- 2.2.3 Cast copper, solder type: to ANSI/ASME B16.18.
- 2.2.4 Wrought copper and copper alloy, solder type: to ANSI/ASME B16.22.

2.3 JOINTS

- 2.3.1 Rubber gaskets, 1.6 mm thick: to ANSI/AWWA C111/A21.11.
- 2.3.2 Bolts, nuts, hex head and washers: to ASTM A307, heavy series.
- 2.3.3 Solder: 95/5 tin copper alloy.
- 2.3.4 Teflon tape: for threaded joints.
- 2.3.5 Dielectric connections between dissimilar metals: isolating flanges.

2.4 VALVES

- 2.4.1 Refer to Section 23 05 23.

2.5 PROTECTIVE CONDUIT

- 2.5.1 Plastic drainage pipe, type DVW, to Section 23 13 16 - Drainage Waste and Vent Piping.

3 EXECUTION

3.1 INSTALLATION

- 3.1.1 Install in accordance with Canadian Plumbing Code, Provincial Plumbing Code and local authority having jurisdiction.

- 3.1.2 Install pipe work in accordance with Section 15101 - Installation of Pipe Work, supplemented as specified herein.
- 3.1.3 Assemble piping using fittings manufactured to ANSI standards.
- 3.1.4 Install CWS piping below and away from HWS and HWC and other hot piping so as to maintain temperature of cold water as low as possible.
- 3.1.5 Connect to fixtures and equipment in accordance with manufacturer's written instructions unless otherwise indicated.
- 3.1.6 Buried tubing:
 - 3.1.6.1 Lay in well compacted washed sand in accordance with AWWA Class B bedding.
 - 3.1.6.2 Bend tubing without crimping or constriction. Minimize use of fittings.
 - 3.1.6.3 Install buried tubing located under building slab in protective conduit (except floor drain trap primer piping)
- 3.2 PRESSURE TESTS
 - 3.2.1 Conform to requirements of Section 23 01 10.
 - 3.2.2 Test pressure: greater of 1 1/2 times maximum system operating pressure or 860 kPa.
- 3.3 FLUSHING AND CLEANING
 - 3.3.1 Flush entire system for 8 h. Ensure outlets flushed for 2 h. Let stand for 24 h, then draw one sample off longest run. Submit to testing laboratory to verify that system is clean. Let system flush for additional 2 h, then draw off another sample for testing.
- 3.4 PRE-START-UP INSPECTIONS
 - 3.4.1 Systems to be complete, prior to flushing, testing and start-up.
 - 3.4.2 Verify that system can be completely drained.
 - 3.4.3 Ensure that pressure booster systems are operating properly.
 - 3.4.4 Ensure that air chambers, expansion compensators are installed properly.
- 3.5 DISINFECTION
 - 3.5.1 Flush out, disinfect and rinse system to requirements of authority having jurisdiction and approval of Owner.
 - 3.5.2 Upon completion, provide laboratory test reports on water quality for Owner approval.

3.6 START-UP

3.6.1 Timing: Start up after:

- 3.6.1.1 Pressure tests have been completed.
- 3.6.1.2 Disinfection procedures have been completed.
- 3.6.1.3 Certificate of static completion has been issued.
- 3.6.1.4 Water treatment systems operational.

3.6.2 Provide continuous supervision during start-up.

3.6.3 Start-up procedures:

- 3.6.3.1 Establish circulation and ensure that air is eliminated.
- 3.6.3.2 Check pressurization to ensure proper operation and to prevent water hammer, flashing and/or cavitation.
- 3.6.3.3 Check control, limit, safety devices for normal and safe operation.

3.6.4 Rectify start-up deficiencies.

3.7 PERFORMANCE VERIFICATION

3.7.1 Timing:

- 3.7.1.1 After pressure and leakage tests and disinfection completed, and certificate of completion has been issued by authority having jurisdiction.

3.7.2 Procedures:

- 3.7.2.1 Verify that flow rate and pressure meet Design Criteria.
- 3.7.2.2 TAB Hot Water Recirc in accordance with Section 23 05 93 - Testing Adjusting and Balancing (TAB) of Mechanical Systems.
- 3.7.2.3 Adjust pressure regulating valves while withdrawal is maximum and inlet pressure is minimum.
- 3.7.2.4 Sterilize DCW and DHWR systems for Legionella control.
- 3.7.2.5 Verify performance of temperature controls.
- 3.7.2.6 Verify compliance with safety and health requirements.
- 3.7.2.7 Check for proper operation of water hammer arrestors. Run one outlet for 10 seconds, then shut of water immediately. If water hammer occurs, replace water hammer arrestor or re-charge air chambers. Repeat for outlets and flush valves.
- 3.7.2.8 Confirm water quality consistent with supply standards, verifying that no residuals remain as a result of flushing and/or cleaning.

3.7.3 Reports:

- 3.7.3.1 In accordance with Division 0 - Commissioning: Reports, using report forms as specified in Division 0 - Commissioning: Report Forms and Schematics.
- 3.7.3.2 Include certificate of water flow and pressure tests conducted on incoming water service, demonstrating adequacy of flow and pressure.

END OF SECTION

1 GENERAL

1.1 RELATED REQUIREMENTS

1.1.1 Section 23 01 10 - Mechanical General Provisions.

1.1.2 Section 23 01 20 - Mechanical Submittals.

1.1.3 Electrical.

1.2 SHOP DRAWINGS AND PRODUCT DATA

1.2.1 Submit shop drawings and product data in accordance with Section 23 01 20 - Mechanical Submittals.

1.2.2 Indicate:

1.2.2.1 Equipment, including connections, fittings, control assemblies and ancillaries. Identify whether factory or field assembled.

1.2.2.2 Wiring and schematic diagrams.

1.2.2.3 Dimensions and recommended installation.

1.2.2.4 Pump performance and efficiency curves.

1.3 MAINTENANCE DATA

1.3.1 Provide maintenance data for incorporation into manual specified in Section 23 01 20 - Mechanical Submittals.

1.3.2 Data to include:

1.3.2.1 Manufacturers name, type, model year, capacity and serial number.

1.3.2.2 Details of operation, servicing and maintenance.

1.3.2.3 Recommended spare parts list with names and addresses.

2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

2.1.1 Circulating Pumps: Armstrong, Bell and Gossett, Darling, Taco.

2.2 DOMESTIC HOT WATER CIRCULATING PUMPS

2.2.1 Capacity: as indicated.

2.2.2 Construction: closed-coupled, in-line centrifugal, all bronze construction, stainless steel shaft, stainless steel or bronze shaft sleeve, two oil lubricated bronze sleeves or ball bearings. Design for 860 kPa wp and 105 Deg. C continuous service.

2.2.3 Motor: drip-proof, with thermal overload protection.

2.2.4 Acceptable material: Armstrong.

3 EXECUTION

3.1 INSTALLATION

3.1.1 Make piping and electrical connections to pump and motor assembly and controls as indicated.

3.1.2 Ensure pump and motor assembly do not support piping.

3.1.3 Confirm pump rotation is correct.

3.1.4 Set up and adjust controls.

END OF SECTION

1 GENERAL

1.1 RELATED SECTIONS

- 1.1.1 Section 23 07 19 - Installation of Pipework
- 1.1.2 Section 23 01 10 - Mechanical General Requirements

1.2 SCOPE

- 1.2.1 This section applies to sanitary and storm piping within the building and under the building within the building foundation footprint.

1.3 REFERENCES

- 1.3.1 American Society for Testing and Materials (ASTM)
 - 1.3.1.1 ASTM B32, Specification for Solder Metal.
 - 1.3.1.2 ASTM B306, Specification for Copper Drainage Tube (DWV).
 - 1.3.1.3 ASTM C564, Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
 - 1.3.1.4 ASTM C1053 - Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (DWV) Applications.
 - 1.3.1.5 ASTM D2235, Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
 - 1.3.1.6 ASTM D2564, Specification for Solvent Cements for Poly(Vinyl-Chloride) (PVC) Plastic Piping Systems.
 - 1.3.1.7 ASTM D4101, Standard Specification for Polypropylene Injection and Extrusion Materials
 - 1.3.1.8 ASTM F1412, Standard Specification for Polyolefin Pipe and Fittings for Corrosive Waste Drainage Systems
- 1.3.2 Canadian Standards Association (CSA)
 - 1.3.2.1 CAN/CSA-B70, Cast Iron Soil Pipe, Fittings and Means of Joining.
 - 1.3.2.2 CAN/CSA-B125, Plumbing Fittings.
 - 1.3.2.3 CSA-B1800 Series, ABS Drain, Waste and Vent Pipe and Pipe Fittings.
 - 1.3.2.4 CSA-B181.2, PVC Drain, Waste and Vent Pipe and Pipe Fittings.
 - 1.3.2.5 CSA-B181.3, Polyolefin Laboratory Drainage System
 - 1.3.2.6 CSA-B182.1, Plastic Drain and Sewer Pipe and Pipe Fittings.
 - 1.3.2.7 CSA-B182.11, Recommended Practice for the Installation of Thermoplastic Drain, Storm, and Sewer Pipe and Fittings

1.4 SUBMITTALS

- 1.4.1 Submit test reports in accordance with Section 23 01 10.
- 1.4.2 Provide maintenance data for incorporation into manual specified in Section 23 01 10.

2 PRODUCTS

2.1 COPPER TUBE AND FITTINGS

2.1.1 Above ground sanitary storm and vent Type DWV to: ASTM B306.

2.1.1.1 Fittings.

2.1.1.1.1 Cast brass: to CAN/CSA-B125.

2.1.1.1.2 Wrought copper: to CAN/CSA-B125.

2.1.1.2 Solder: to ASTM B32.

2.2 CAST IRON PIPING AND FITTINGS

2.2.1 Above ground sanitary storm and vent: to CAN/CSA-B70.

2.2.1.1 Joints.

2.2.1.1.1 Mechanical joints: neoprene or butyl rubber compression gaskets with stainless steel clamps.

2.3 PLASTIC PIPING AND FITTINGS

2.3.1 For buried sanitary and storm drainage piping:

2.3.1.1 ABS type DWV to CSA-B181.1.

2.3.1.1.1 Joints: solvent weld to ASTM D2235.

2.3.1.2 PVC type DWV to CSA-B181.2.

2.3.1.2.1 Joints: solvent weld to ASTM D2564.

2.3.2 For buried storm drainage piping:

2.3.2.1 PVC drain line piping to CSA-B182.1.

2.3.2.1.1 Joints up to NPS 6: solvent weld.

2.3.2.1.2 Joints over NPS 8 and over: gasket bell.

3 EXECUTION

3.1 INSTALLATION

3.1.1 Install in accordance with Section 23 07 19, and as specified herein.

3.1.2 Install in accordance with CSA-B182.11, Canadian Plumbing Code, Provincial Plumbing Code and local authority having jurisdiction.

3.1.3 Hang all piping buried under structural slabs. Hangers to attach to structural slab using stainless steel clevis and hanger rod assembly.

3.2 TESTING

- 3.2.1 Pressure test buried systems before backfilling.
- 3.2.2 Perform ball test on all underground piping prior to burial. Schedule for Owner to witness test.
- 3.2.3 Hydraulically test to verify grades and freedom from obstructions.

3.3 PERFORMANCE VERIFICATION

- 3.3.1 Cleanouts:
 - 3.3.1.1 Ensure accessible and that access doors are correctly located.
 - 3.3.1.2 Open, cover with linseed oil and re-seal.
 - 3.3.1.3 Verify that cleanout rods can probe as far as the next cleanout, at least.
- 3.3.2 Test to ensure traps are fully and permanently primed.
- 3.3.3 Storm water drainage:
 - 3.3.3.1 Verify domes are secure.
 - 3.3.3.2 Verify provisions for movement of roof system.
- 3.3.4 Ensure that fixtures are properly anchored, connected to system and effectively vented.
- 3.3.5 Ensure pipe identification is completed.

END OF SECTION

1 GENERAL

1.1 REFERENCES

1.1.1 ASTM International Inc.

1.1.1.1 ASTM B32-08, Standard Specification for Solder Metal.

1.1.1.2 ASTM B306-02, Standard Specification for Copper Drainage Tube (DWV).

1.1.1.3 ASTM C564-03a, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.

1.1.2 Canadian Standards Association (CSA International).

1.1.2.1 CAN/CSA-B70-06, Cast Iron Soil Pipe, Fittings and Means of Joining.

1.1.2.2 CAN/CSA-B125.3-05, Plumbing Fittings.

1.1.3 Green Seal Environmental Standards (GSES)

1.1.3.1 Standard GS-36-00, Commercial Adhesives.

1.2 DELIVERY, STORAGE AND HANDLING

1.2.1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.

1.2.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

1.2.3 Packaging Waste Management: remove for reuse or recycling all pallets, crates, and packaging materials in accordance with Section 01 74 19 - Waste Management.

2 PRODUCTS

2.1 COPPER TUBE AND FITTINGS

2.1.1 Above ground sanitary and vent Type DWV to: ASTM B306.

2.1.1.1 Fittings.

2.1.1.1.1 Cast brass: to CAN/CSA-B125.3.

2.1.1.1.2 Wrought copper: to CAN/CSA-B125.3.

2.1.1.2 Solder: tin-lead, 50:50, type 50A lead free, tin to ASTM B32.

2.2 CAST IRON PIPING AND FITTINGS

2.2.1 Above ground sanitary, storm and vent: to CAN/CSA-B70.

2.2.2 Joints:

- 2.2.2.1 Mechanical joints:
 - 2.2.2.1.1 Neoprene or butyl rubber compression gaskets with stainless steel clamps.

3 EXECUTION

3.1 APPLICATION

- 3.1.1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

- 3.2.1 In accordance with Section 23 05 05 - Installation of Pipework.
- 3.2.2 Install in accordance with National Plumbing Code and local authority having jurisdiction.

3.3 TESTING

- 3.3.1 Pressure test buried systems before backfilling.
- 3.3.2 Hydraulically test to verify grades and freedom from obstructions.

3.4 PERFORMANCE VERIFICATION

- 3.4.1 Cleanouts:
 - 3.4.1.1 Ensure accessible and that access doors are correctly located.
 - 3.4.1.2 Open, cover with linseed oil and re-seal.
 - 3.4.1.3 Verify that cleanout rods can probe as far as the next cleanout, at least.
- 3.4.2 Test to ensure traps are fully and permanently primed.
- 3.4.3 Storm water drainage:
 - 3.4.3.1 Verify domes are secure.
 - 3.4.3.2 Ensure weirs are correctly sized and installed correctly.
 - 3.4.3.3 Verify provisions for movement of roof system.
- 3.4.4 Ensure that fixtures are properly anchored, connected to system and effectively vented.
- 3.4.5 Affix applicable label (storm, sanitary, vent, pump discharge etc.) c/w directional arrows every floor or 4.5 m (whichever is less).

END OF SECTION

1 GENERAL

1.1 RELATED REQUIREMENTS

1.1.1 Section 23 01 10: Mechanical General Provisions.

1.1.2 Section 23 01 20: Mechanical Submittals.

1.2 REFERENCE STANDARDS

1.2.1 Do the work in accordance with CAN3-B45 Series-M81 and CSA B125-1975 except where specified otherwise.

1.2.2 ANSI A117.1: Accessible and Usable Buildings and Facilities

1.3 PRODUCT DATA

1.3.1 Submit product data in accordance with Section 23 01 20 - Mechanical Submittals.

1.4 MAINTENANCE DATA

1.4.1 Provide maintenance data for incorporation into manual specified in Section 23 01 20 - Mechanical Submittals.

1.4.2 Data to include:

1.4.2.1 Description of equipment giving manufacturers name, type, model, year and capacity.

1.4.2.2 Details of operation, servicing and maintenance.

1.4.2.3 Recommended spare parts list.

1.5 FIXTURES AND TRIM

1.5.1 Architectural drawings to govern in determination of number and location of fixtures.

1.5.2 Fixtures to be product of one manufacturer and of same type in any one washroom or location.

1.5.3 Trim to be product of one manufacturer and of same type in any one washroom or location.

1.5.4 Exposed plumbing brass to be chrome plated.

2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

2.1.1 Water Closets and Urinals: American Standard, Crane, Kohler.

- 2.1.2 Flush Valves: Zurn, Sloan, Delta
- 2.1.3 Stainless Steel Sinks: Waltec Sinkwear, American Standard, Arista Newman.
- 2.1.4 Molded Sinks: Fiat, Cambridge Brass (molded sinks), Zurn.
- 2.1.5 Stainless Steel Drinking Fountains: Haws, Brooks, Sunroc, Elkay.
- 2.1.6 rim: Crane, Cambridge Brass (Delta), Waltec, Zurn & Sloan flush valves.
- 2.1.7 Mixing Valves: Leonard, Symmons, Lawler, Bradley.

2.2 FIXTURE SUPPLIES

- 2.2.1 Chrome plated rigid fixture supplies with screwdriver stops, reducers and escutcheons on each service to each fixture.

2.3 CHAIR CARRIERS

- 2.3.1 Provide for all wall mounted plumbing fixtures, factory manufactured floor mounted chair carrier systems.

2.4 FIXTURE TRAPS

- 2.4.1 Brass P traps complete with cleanouts on all fixtures which do not have built-in traps.

2.5 ROUGHING-IN OF FIXTURES

- 2.5.1 Rough-in for equipment by others complete with valved supplies, wastes and vents, capped.

3 EXECUTION

3.1 FIXTURE INSTALLATION

- 3.1.1 Connect fixtures complete with supplies with isolation stops and drains, trapped, supported level and square. Hot water faucets shall be on left. Fixtures on outside walls to have supplies from floor; other fixtures to be served from wall.

- 3.1.2 Fixture Mounting heights to be as follows:

- 3.1.2.1 Urinals: 375 mm AFF.
- 3.1.2.2 Drinking Fountains: 675 mm AFF from finished floor to rim.
- 3.1.2.3 Wall Hung Lavs: 780 mm from finished floor to rim.
- 3.1.2.4 Physically Handicap: Fixtures designed for handicap accessibility to be mounted at height in compliance with BCBC.

Coordinate and confirm all mounting heights with Owner and Calgary Board of Education prior to installation.

- 3.1.3 Provide backflow protection where required on all potable water connections to all fixtures and or equipment to prevent contamination to potable water source due to backflow in full compliance with Plumbing codes and local authorities.

END OF SECTION

1 GENERAL

1.1 GENERAL

- 1.1.1 This section covers items common to all sections of Mechanical Divisions (Divisions 21, 23 and 25).

1.2 REQUIREMENTS INCLUDED

- 1.2.1 Procedures for demonstration and instruction of equipment and systems to Owner's personnel.

1.3 DESCRIPTION

- 1.3.1 Demonstrate scheduled operation and maintenance of equipment and systems to Owner's personnel with initial instructions two weeks prior to date of substantial performance with additional instructions scheduled as specified.
- 1.3.2 Owner will provide list of personnel to receive instructions, and will coordinate their attendance at agreed-upon times.

1.4 QUALITY CONTROL

- 1.4.1 When specified in individual Sections, require manufacturer to provide authorized representative to demonstrate operation of equipment and systems, instruct Owner's personnel, and provide a written report that indicates that demonstration and instructions have been completed.

1.5 SUBMITTALS

- 1.5.1 Submit schedule of time and date for demonstration of each item of equipment and each system two weeks prior to designated dates, for Owner's approval.
- 1.5.2 Submit reports within one week after completion of demonstration, that demonstration and instructions have been satisfactorily completed.
- 1.5.3 Give time and date of each demonstration, with a list of persons present.
- 1.5.4 Provide reports for inclusion in operating and maintenance manuals in accordance with Section 23 01 20 - Submittals.

1.6 CONDITIONS FOR DEMONSTRATIONS

- 1.6.1 Equipment has been inspected and put into operation in accordance with Section 23 01 10 - General Provisions and Section 23 01 20 - Mechanical Submittals.
- 1.6.2 Testing, adjusting, and balancing has been performed in accordance with Section 23 05 93 - Testing, Adjusting and Balancing (TAB) of Mechanical Systems and equipment and systems are fully operational.

- 1.6.3 Provide copies of completed operation and maintenance manuals for use in demonstrations and instructions.

1.7 PREPARATION

- 1.7.1 Verify that conditions for demonstration and instructions comply with requirements.
- 1.7.2 Verify that designated personnel are present.

1.8 DEMONSTRATION AND INSTRUCTIONS

- 1.8.1 Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, and maintenance of each item of equipment at scheduled agreed upon times, at the equipment or designated location.
- 1.8.2 Instruct personnel in all phases of operation and maintenance using operation and maintenance manuals as the basis of instruction.
- 1.8.3 Review contents of manual in detail to explain all aspects of operation and maintenance.
- 1.8.4 Prepare and insert additional data in operations and maintenance manuals when the need for additional data becomes apparent during instructions.

1.9 TIME ALLOCATED FOR INSTRUCTIONS

- 1.9.1 The amount of time required for instruction of each item of equipment or system shall be as follows:
 - 1.9.1.1 Site Services: 2 hours instruction.
 - 1.9.1.2 Plumbing Systems: 4 hours of instruction.
 - 1.9.1.3 Fire Protection Systems: 3 hours of instruction.
 - 1.9.1.4 Ventilation and Air Conditioning Systems: 6 hours of instruction.
 - 1.9.1.5 Control Systems: 24 hours of instruction. Instructions to be carried out in 6 periods of 4 hours each scheduled with the owner.

END OF SECTION

1 GENERAL

1.1 GENERAL

- 1.1.1 This section covers items common to all sections of Mechanical Divisions (Divisions 21, 23 and 25).

1.2 INTENT

- 1.2.1 Inspect, start and test each piece of mechanical equipment and system. Verify that equipment and systems have been properly installed and are operating at a level that meets specified requirements.

1.3 FACTORY TRAINED REPRESENTATIVES

- 1.3.1 Use factory trained representatives and submit manufacturer's check sheets for starting following specialty equipment:

- 1.3.1.1 Air handling units.
- 1.3.1.2 Boilers.
- 1.3.1.3 Control components.
- 1.3.1.4 Chemical cleaning and treatment.
- 1.3.1.5 Pumps.

- 1.3.2 Use manufacturer's factory trained personnel where required to maintain manufacturer's warranty.

2 EXECUTION

2.1 FLUID HANDLING EQUIPMENT – PUMPS

2.1.1 Pre-Starting:

- 2.1.1.1 Verify that installation is as drawn and specified and in accordance with manufacturer's Recommendations.
- 2.1.1.2 Complete manufacturer's installation and start-up check sheets and include following items on check sheets:
 - 2.1.1.2.1 Pump is level. Pump is properly aligned and installed to manufacturer's recommendations.
 - 2.1.1.2.2 Isolation valves, strainers, check valve, pressure gauges, by-pass filter and flow meter are installed properly.
 - 2.1.1.2.3 Pump suction has sufficient length of straight run piping.
 - 2.1.1.2.4 Air has been completely bled off piping system.
 - 2.1.1.2.5 Expansion tank is charged and on-line.
 - 2.1.1.2.6 Strainers have clean screens in place.

2.1.1.2.7 Where specified for large pumps, check pump base vibration isolation and flexible connections on water pipes are properly installed.

2.1.1.2.8 Nameplate is readily visible.

2.1.1.2.9 Check clearance space is adequate for pump servicing and removal.

2.1.2 Starting:

2.1.2.1 Start as recommended by manufacturer.

2.1.2.2 Fill out start-up sheets and attach copy with Contractor Start-Up Report.

2.1.2.3 Check impeller is rotating in correct direction.

2.1.3 Post Starting:

2.1.3.1 Run-in pumps for minimum 12 continuous hours.

2.1.3.2 Ensure flows through parallel pumps are equally balanced.

2.1.3.3 Ensure mechanical seals do not leak, or packing gland type seals are wetted.

2.1.3.4 Check pump NPSH - net positive suction head.

2.1.3.5 Where vibration isolation is specified, check for correct static deflection of unit vibration isolators, and that start up and shut down deflection is within resiliencelimits of isolators and flexible connections.

2.1.3.6 Verify that motor has sufficient air flow through casing to provide cooling.

2.1.4 Pre-Interim Acceptance:

2.1.4.1 Clean strainers.

2.1.4.2 Replace shaft seals if pump has been used to degrease system.

2.2 FLUID HANDLING EQUIPMENT - COILS

2.2.1 Pre-Starting:

2.2.1.1 Verify that installation is as drawn and specified and in accordance with manufacturer's recommendations.

2.2.1.2 Complete manufacturer's installation and start-up check sheets and include following items on check sheets:

2.2.1.2.1 Pipe connections have been correctly made for counter current heat exchange between air and fluid.

2.2.1.2.2 Clearances have been provided and piping is flanged for easy removal and servicing.

2.2.1.2.3 Coil air vent and drain valve and deadleg drain valves have been provided.

2.2.1.2.4 Coil is sloped to ensure complete drain down.

- 2.2.1.2.5 Pressure and temperature tapings, Pete's plugs, have been provided.
- 2.2.1.2.6 Fins inspected and combed straight as required.
- 2.2.1.2.7 Cooling coil drain pan and trapped drain line installed correctly.
- 2.2.1.2.8 Labels are clearly visible
- 2.2.1.2.9 Control valve piping is connected for correct flow through valve body and for required fail safe action of valve.

2.2.2 Starting:

- 2.2.2.1 Check operation of cooling coil condensate drain with supply fan at maximum airflow. Ensure that condensate will drain away against maximum suction pressure of supply fan. Check for and eliminate condensate carry over at maximum air velocity.

2.2.3 Pre-Interim Acceptance: not applicable.

2.3 FLUID HANDLING EQUIPMENT - MISCELLANEOUS

2.3.1 Gauges and Thermometers:

- 2.3.1.1 Confirm all gauges and thermometers can be read from the floor level and are installed as recommended by manufacturer.
- 2.3.1.2 Calibrate.

2.3.2 Verify following equipment is installed as recommended by manufacturer. Fill out manufacturer's start-up sheets:

- 2.3.2.1 PRVs.
- 2.3.2.2 Air eliminators.
- 2.3.2.3 Strainers.
- 2.3.2.4 Check valves.
- 2.3.2.5 Balancing valves.
- 2.3.2.6 Plumbing fixtures.
- 2.3.2.7 Backflow preventers.
- 2.3.2.8 Vacuum breakers.

2.4 AIR HANDLING EQUIPMENT - AIR HANDLING UNITS

2.4.1 Pre-Starting:

- 2.4.1.1 Check that installation is as drawn and specified and in accordance with manufacturer's recommendations.
- 2.4.1.2 Complete manufacturer's installation and start-up check sheets including following:

- 2.4.1.2.1 Fresh and Recirculation air motorized dampers, operation and size.
 - 2.4.1.2.2 Filters.
 - 2.4.1.2.3 Check that fan base vibration isolation and flexible connections to ductwork are properly installed.
 - 2.4.1.2.4 Special features, access doors, liners, inlet vanes, labels.
- 2.4.1.3 Lubricate bearings on fans as recommended by manufacturer. Ensure fan wheels rotate in correct direction without binding. Adjust belts to proper alignment and tension.
- 2.4.1.4 Vacuum clean air systems.
- 2.4.1.5 Ensure temporary filters are installed. Never operate system without filters installed.
- 2.4.1.6 Ensure all balancing and fire dampers are open and ductwork is complete.
- 2.4.1.7 Ensure all coils are in operation. If outside air temperature is less than 2°C ensure coils are dry or filled with glycol.
- 2.4.1.8 On parallel fan systems ensure backdraft dampers are installed.
- 2.4.1.9 Ensure electrical connections are complete and system disconnects are within sight of unit.
- 2.4.1.10 Ensure controls are operational.
- 2.4.1.11 Ensure inlet and discharge duct geometry is correct.
- 2.4.2 Starting:
 - 2.4.2.1 Follow manufacturer's recommendations.
- 2.4.3 Post-Starting:
 - 2.4.3.1 Start fan and check for vibration free operation.
 - 2.4.3.2 Check for correct static deflection of unit vibration isolators, and that start-up and shut down deflection is within resilience limits.
 - 2.4.3.3 Run for one day and check filters and coils for bypass. Seal as required.
 - 2.4.3.4 Check that bearings are not overheating.
- 2.4.4 Pre-Interim Acceptance:
 - 2.4.4.1 Replace temporary filters with permanent filters.
 - 2.4.4.2 Vacuum clean heating and cooling coils.
 - 2.4.4.3 Lubricate bearings.
 - 2.4.4.4 Check belts for tension and wear.
- 2.5 AIR HANDLING EQUIPMENT - FANS
 - 2.5.1 Pre-Starting:

- 2.5.1.1 Check that installation is as drawn and specified and in accordance with manufacturer's recommendations.
- 2.5.1.2 Complete manufacturer's installation and start-up check sheets including following:
 - 2.5.1.2.1 Backdraft dampers.
 - 2.5.1.2.2 Accessories.
 - 2.5.1.2.3 Special features.
 - 2.5.1.2.4 Check that fan base vibration isolation and flexible connections to ductwork are properly installed.
- 2.5.1.3 Lubricate bearings on fans as recommended by manufacturer.
- 2.5.1.4 Ensure fan wheels rotate in correct direction without binding.
- 2.5.1.5 Adjust belts to proper alignment and tension.
- 2.5.1.6 Ensure ductwork and fan casing is free of dirt or foreign material.
- 2.5.1.7 Ensure electrical connections are complete and disconnect is within sight of fan.
- 2.5.1.8 Ensure inlet and discharge duct geometry is correct.
- 2.5.2 Starting:
 - 2.5.2.1 Follow manufacturer's recommendations.
- 2.5.3 Post-Starting:
 - 2.5.3.1 Start fan, for variable speed fans run up to maximum speed, and check for vibration free operation.
 - 2.5.3.2 Check for correct static deflection of unit vibration isolators, and that start-up and shut down deflection is within resilience limits.
 - 2.5.3.3 Check that bearings are not over heating.
- 2.5.4 Pre-Interim Acceptance:
 - 2.5.4.1 Lubricate bearings.
 - 2.5.4.2 Check belts for tension and wear.
- 2.6 AIR HANDLING EQUIPMENT - UNIT AND CABINET HEATERS
 - 2.6.1 Pre-Starting:
 - 2.6.1.1 Check each installation is as drawn and specified and in accordance with manufacturer's recommendations. Check following:
 - 2.6.1.1.1 Piping connections.
 - 2.6.1.1.2 Unit vibration isolation.
 - 2.6.1.1.3 Ducting connections.
 - 2.6.1.1.4 Controls.
 - 2.6.1.1.5 Disconnect switches.
 - 2.6.1.1.6 Unit clean.

2.6.2 Starting: as recommended by manufacturer.

2.6.3 Pre-Interim Acceptance: not applicable.

2.7 MISCELLANEOUSEQUIPMENT - TANKS

2.7.1 Pre-Starting:

2.7.1.1 Verify that installation is as drawn and specified and in accordance with manufacturer's recommendations. Check following:

2.7.1.1.1 Tank is level on housekeeping base.

2.7.1.1.2 No visible damage to vessel.

2.7.1.1.3 Check PRVs for correct operation and specified relief pressure. Adjust as required.

2.7.1.1.4 Clearances have been provided and piping is flanged for easy removal and servicing.

2.7.1.1.5 Labels are clearly visible.

2.7.1.1.6 Controls, gauges, alarm devices, etc. are operational.

2.7.1.1.7 Accessports/manholes provided.

2.7.1.1.8 Piping sizes - inlet/outlet are correct.

2.7.1.1.9 Lining is intact and not damaged.

2.7.1.1.10 Tank has dielectric unions on piping connections.

2.7.2 Starting: not applicable.

2.7.3 Post-Starting:

2.7.3.1 Verify operation of:

2.7.3.1.1 Drain line.

2.7.3.1.2 Make-up line if applicable.

2.7.3.1.3 Gauge glass.

2.7.3.1.4 Diaphragm if applicable.

2.7.4 Pre-Interim Acceptable: not applicable.

2.8 MISCELLANEOUSEQUIPMENT – FIRE EXTINGUISHERS

2.8.1 Check the number, make, model and capacity of each portable fire extinguisher.

2.8.2 Check the pressure drop on each extinguisher over 20 day period. Replace units losing charge.

2.8.3 Check that all cabinets are clean and door latch functions correctly.

2.9 OPERATIONAL TESTS

- 2.9.1 Operational tests are to be conducted to demonstrate that equipment and systems meet specified performance only after mechanical installations have been completed and pressure tested. Notify the Balancer and Owner as soon as conditions permit. Make changes, repairs, adjustments, and replacements required as tests may indicate.
- 2.9.2 Conduct pre-operational tests, processes and inspections in presence of the Owner if so requested by the Owner.
- 2.9.3 Conduct final operational tests in presence of the Owner. Vary loads to illustrate start-up and shut down sequences. Simulate emergency conditions for safety shut downs, with automatic and manual reset. Repair and retest defects until satisfactory results are achieved. Make final adjustments to suit exact building conditions.

2.10 AIR SYSTEMS

- 2.10.1 Inspect air systems including ductwork layout, support, and vibration isolation before pressure testing any section of ductwork. Notify Owner when work is ready for inspection.
- 2.10.2 Pressure test sections of ductwork, in accordance with Section 15042, prior to application of insulation or concealment. Include pressure testing of ductwork on commissioning schedule and notify Owner prior to any system pressure tests.
- 2.10.3 Air Handling Unit: start-up and performance verification using manufacturer's representative. Provide 6 working days notice to the Owner.
- 2.10.4 Start up coil circulators, exhaust air systems, etc.
- 2.10.5 Demonstrate operation of mixing section, blender, filters, freeze protect, fire alarm interlocks, etc.
- 2.10.6 If necessary provide and change pulley drives to correct volume up or down on constant volume systems, and to correct volume up on variable volume systems.
- 2.10.7 Complete and submit Air Systems Start-up report as specified in General Mechanical Starting and Testing Requirements.
- 2.10.8 Conduct Mechanical Systems Demonstration and Instruction in accordance with Section 23 01 30.

2.11 HYDRONICS SYSTEMS

- 2.11.1 Inspect piping layout, pipe support, expansion provisions, slope for draining and venting, vibration isolation, etc. before pressure testing any section of pipe. Notify Owner when work is ready for inspection.
- 2.11.2 Pressure test sections of pipe, in accordance with Section 23 01 10, prior to application of insulation or to concealment.
- 2.11.3 Pressure test each completed system, in accordance with Section 23 01 10, before any equipment is started. Notify Owner 6 working days prior to any system pressure test.
- 2.11.4 Start-up pumps.
- 2.11.5 Heating appliance: perform start-up and performance verification using manufacturer's representative. Provide 6 working days notice to the Owner.
- 2.11.6 Notify Owner and Balancing contractor when the systems are ready for rough balancing. The systems will be rough balanced to ensure fluid circulation in every circuit. Cooling systems will be rough balanced by velocity or pressure drop measurements at each circuit or component. Heating system will be rough balanced by temperature drop measurement.
- 2.11.7 Chemically clean water filled system in accordance with Section 23 25 13. Notify Owner six (6) working days prior to any system cleaning.
- 2.11.8 Chemically treat water filled systems in accordance with Section 23 25 13.
- 2.11.9 Notify the Owner and Balancing Contractor when systems are ready for final balancing.
- 2.11.10 Check system for fluid or pump noise in pipes. Rectify as necessary.
- 2.11.11 Provided the flow rate exceeds that specified, shave impeller on pumps larger than 1.5 kW if current draw exceeds motor full load amps or if there is excess flow which results in excessive pipe noise in adjacent occupied areas.
- 2.11.12 Complete and submit Hydronic systems Start-up report as specified in Section 23 01 50.
- 2.11.13 Conduct Mechanical Equipment and Systems Demonstration and Instruction in accordance with Section 23 01 30

2.12 CONTROL SYSTEMS

2.12.1 Pressure test completed pneumatic system, in accordance with Section 23 01 10, before any equipment is started. Notify Owner six (6) working days prior to system pressure test.

2.12.2 Start-Up and performance test control air compressor and drier.

2.12.3 Check start/stop schedules, alarms, etc. in accordance with Controls Specifications.

2.12.4 Commence trial use period in accordance with Controls Specifications.

2.13 DOMESTIC WATER SYSTEMS

2.13.1 Inspect domestic water systems including piping layout, pipe support, expansion provisions, and slope for draining and venting, before pressure testing any section of pipe. Notify Owner when work is ready for inspection.

2.13.2 Pressure test sections of pipe, in accordance with Section 23 01 10, prior to application of insulation or to concealment.

2.13.3 Pressure test each completed system, in accordance with Section 23 01 10, before any equipment is started. Notify Owner six (6) working days prior to any system pressure test.

2.13.4 Start domestic hot water systems' circulator pumps.

2.13.5 Domestic hot water heating appliance: Perform start-up and performance verification using manufacturer's representative. Provide 6 working days notice to the Owner.

2.13.6 Balance Domestic Hot Water system return circulation circuits by temperature drop measurement.

2.13.7 Sterilize Domestic water systems in accordance with Section 22 11 16. Notify Owner 6 working days prior to any system sterilization.

2.13.8 Ensure all air chambers and expansion compensators are properly installed.

2.13.9 Ensure entire system can be completely drained.

2.13.10 Check operation of water hammer arrestors. Let one outlet run for ten seconds, then shut water off quickly. If water hammer occurs, replace water hammer arrestor. Repeat for each outlet and flush valve.

2.13.11 Complete and submit Domestic Water systems Start-up report as specified in Mechanical Equipment/System Startup and Testing.

2.13.12 Conduct Mechanical Equipment and Systems Demonstration and Instruction in accordance with Section 23 01 30.

2.14 PLUMBING DRAINAGE SYSTEMS

- 2.14.1 Inspect plumbing drainage systems including above ground drainage piping layout, pipe support, slope, venting, before pressure testing or concealing any section of the work. Notify Owner when work is ready for inspection.
- 2.14.2 Hydraulically test above ground installations within buildings in accordance with Section 23 01 10. Notify Owner 6 working days prior to any system pressure test.
- 2.14.3 Ensure all traps are fully primed.
- 2.14.4 Ensure all fixtures are properly anchored and connected to system.
- 2.14.5 Flush each valve, drain each sink and operate each fixture to ensure drainage and trap anti-siphon venting is effective.
- 2.14.6 Open each cleanout, cover with linseed oil and reseal each cleanout. Ensure each cleanout is fully accessible and access doors are properly installed. Check cleanouts after building finishes (flooring, wall covering) have been installed.
- 2.14.7 Ensure roof drain metal domes are installed. Ensure storm piping is free of debris or roof insulation ballast. Remove caps as required. Verify insulation on piping is as specified in Section 22 07 19 and 23 07 19.
- 2.14.8 Complete and submit Drainage systems Start-up report.
- 2.14.9 Conduct Mechanical Equipment and Systems Demonstration and Instruction in accordance with Mechanical Equipment/System Startup and Testing.

END OF SECTION

1 **GENERAL**

1.1 RELATED DOCUMENTS

1.1.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

1.2.1 Section Includes:

- 1.2.1.1 Flexible-hose packless expansion joints and loops.
- 1.2.1.2 Alignment guides and anchors.

1.3 PERFORMANCE REQUIREMENTS

1.3.1 Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

1.3.2 Capability: Products to absorb 200 percent of maximum axial movement between anchors.

1.1 **ACTION SUBMITTALS**

1.3.3 Product Data: For each type of product indicated.

1.3.4 Delegated-Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Engineer seal shall be valid in the jurisdiction of the project.

- 1.3.4.1 Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
- 1.3.4.2 Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
- 1.3.4.3 Alignment Guide Details: Detail field assembly and attachment to building structure.
- 1.3.4.4 Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

1.4 INFORMATIONAL SUBMITTALS

1.4.1 Welding certificates.

1.4.2 Product Certificates: For each type of expansion joint, from manufacturer.

1.5 CLOSEOUT SUBMITTALS

1.5.1 Maintenance Data: For expansion joints to include in maintenance manuals.

1.6 QUALITY ASSURANCE

1.6.1 Welding Qualifications: Qualify procedures and personnel according to the following:

1.6.1.1 AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.6.1.2 ASME Boiler and Pressure Vessel Code: Section IX.

2 PRODUCTS

2.1 PACKLESS EXPANSION JOINTS

2.1.1 Flexible-Hose Packless Expansion Joints:

2.1.1.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following :

2.1.1.1.1 Flex-Hose Co., Inc.

2.1.1.1.2 Flexicraft Industries.

2.1.1.1.3 Flex Pression Ltd.

2.1.1.1.4 Metraflex, Inc.

2.1.1.1.5 Mason Industries, Inc.; Mercer Rubber Co.

2.1.2 Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.

2.1.3 Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.

2.1.4 Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with solder-joint or threaded end connections.

2.1.4.1 Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.

2.1.4.2 Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F and 500 psig at 450 deg F ratings.

2.1.5 Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with threaded end connections.

2.1.5.1 Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.

2.1.5.2 Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F and 315 psig at 450 deg F ratings.

- 2.1.6 Expansion Joints for Steel Piping NPS 2 and Smaller: Carbon-steel fittings with threaded end connections.
 - 2.1.6.1 Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.
 - 2.1.6.2 Stainless-steel hoses and double-braid, stainless-steel sheaths with 700psig at 70 deg F and 515 psig at 600 deg F ratings.
- 2.1.7 Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6: Carbon-steel fittings with flanged or weld end connections.
 - 2.1.7.1 Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.
 - 2.1.7.2 Stainless-steel hoses and double-braid, stainless-steel sheaths with 275 psig at 70 deg F and 200 psig at 600 deg F ratings.
- 2.1.8 Expansion Joints for Steel Piping NPS 8 to NPS 12: Carbon-steel fittings with flanged or weld end connections.
 - 2.1.8.1 Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg F and 90 psig at 600 deg F ratings.
 - 2.1.8.2 Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.
- 2.1.9 Expansion Joints for Steel Piping NPS 14 and Larger: Carbon-steel fittings with flanged or weld end connections.
 - 2.1.9.1 Stainless-steel hoses and double-braid, stainless-steel sheaths with 165psig at 70 deg F and 120 psig at 600 deg F ratings.
- 2.2 ALIGNMENT GUIDES AND ANCHORS
 - 2.2.1 Alignment Guides:
 - 2.2.1.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following :
 - 2.2.1.1.1 Advanced Thermal Systems, Inc.
 - 2.2.1.1.2 Flex-Hose Co., Inc.
 - 2.2.1.1.3 Flexicraft Industries.
 - 2.2.1.1.4 Flex-Weld, Inc.
 - 2.2.1.1.5 Hyspan Precision Products, Inc.
 - 2.2.1.1.6 Metraflex, Inc.
 - 2.2.1.1.7 Mason Industries, Inc.; Mercer Rubber Co.

- 2.2.1.2 Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.

- 2.2.1.2.1 Shell must be sized to accommodate insulation.

2.2.2 Anchor Materials:

- 2.2.2.1 Steel Shapes and Plates: ASTM A 36/A 36M.

- 2.2.2.2 Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.

- 2.2.2.3 Washers: ASTM F 844, steel, plain, flat washers.

- 2.2.2.4 Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

- 2.2.2.4.1 Stud: Threaded, zinc-coated carbon steel.

- 2.2.2.4.2 Expansion Plug: Zinc-coated steel.

- 2.2.2.4.3 Washer and Nut: Zinc-coated steel.

- 2.2.2.5 Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.

- 2.2.2.5.1 Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.

- 2.2.2.5.2 Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.

- 2.2.2.5.3 Washer and Nut: Zinc-coated steel.

3 EXECUTION

3.1 EXPANSION-JOINT INSTALLATION

- 3.1.1 Install expansion joints of sizes matching sizes of piping in which they are installed.

- 3.1.2 Install rubber packless expansion joints according to FSA-NMEJ-702.

3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION

- 3.2.1 Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

- 3.2.2 Connect risers and branch connections to mains with at least five pipe fittings including tee in main.

- 3.2.3 Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.
- 3.2.4 Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

- 3.3.1 Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- 3.3.2 Install two guides on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
- 3.3.3 Attach guides to pipe and secure guides to building structure.
- 3.3.4 Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- 3.3.5 Anchor Attachments:
 - 3.3.5.1 Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 3.3.5.2 Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP- 69, Type 24, U-bolts bolted to anchor.
- 3.3.6 Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
 - 3.3.6.1 Anchor Attachment to Steel Structural Members: Attach by welding.
 - 3.3.6.2 Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
- 3.3.7 Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 23 05 16

1 GENERAL

1.1 REFERENCES

1.1.1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)

1.1.1.1 ANSI/ASME B1.20.1-1983(R2006), Pipe Threads, General Purpose (Inch).

1.1.1.2 ANSI/ASME B16.18-2001, Cast Copper Alloy Solder Joint Pressure Fittings.

1.1.2 ASTM International

1.1.2.1 ASTM A276-08, Standard Specification for Stainless Steel Bars and Shapes.

1.1.2.2 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.

1.1.2.3 ASTM B283-08a, Standard Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).

1.1.2.4 ASTM B505/B505M-08a, Standard Specification for Copper-Base Alloy Continuous Castings.

1.1.3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)

1.1.3.1 MSS-SP-25-1998, Standard Marking System for Valves, Fittings, Flanges and Unions.

1.1.3.2 MSS-SP-80-2008, Bronze Gate Globe, Angle and Check Valves.

1.1.3.3 MSS-SP-110-1996, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

1.2.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

1.2.2 Product Data:

1.2.2.1 Provide manufacturer's printed product literature and data sheets for equipment and systems and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 CLOSEOUT SUBMITTALS

1.3.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

2.1.1 Crane, Toyo, Red & White, Kitz, and Grinnell

2.2 MATERIALS

2.2.1 Valves:

2.2.1.1 Except for specialty valves, to be single manufacturer.

2.2.1.2 Products to have CRN registration numbers.

2.2.2 End Connections:

2.2.2.1 Connection into adjacent piping/tubing:

2.2.2.1.1 Steel pipe systems: screwed ends to ANSI/ASME B1.20.1.

2.2.2.1.2 Copper tube systems: solder ends grooved ends to ANSI/ASME B16.18.

2.2.3 Lockshield Keys:

2.2.3.1 Where lockshield valves are specified, provide 10 keys of each size: malleable iron cadmium plated.

2.2.4 Gate Valves:

2.2.4.1 Requirements common to gate valves, unless specified otherwise:

2.2.4.1.1 Standard specification: MSS SP-80.

2.2.4.1.2 Bonnet: union with hexagonal shoulders.

2.2.4.1.3 Connections: screwed with hexagonal shoulders.

2.2.4.1.4 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.

2.2.4.1.5 Packing: non-asbestos.

2.2.4.1.6 Handwheel: non-ferrous.

2.2.4.1.7 Handwheel Nut: bronze to ASTM B62.

2.2.4.2 NPS 2 and under, non-rising stem, solid wedge disc, Class 150:

2.2.4.3 Body: with long disc guides, screwed bonnet with stem retaining nut.

2.2.4.3.1 Operator: handwheel.

2.2.4.3.2 Basis of Design: Crane 437

2.2.4.4 NPS 2 1/2 – 8, non-rising stem, inside screw, iron trim, solid wedge disc:

2.2.4.5 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, Class 125.

2.2.4.5.1 Disc: Solid offset taper wedge, bronze to ASTM B62.

2.2.4.5.2 Seat Rung's: Renewable Bronze to ASTM B62, screwed into body.

2.2.4.5.3 Stem: bronze to ASTM B62.

2.2.4.5.4 Disc: solid offset taper wedge, cast iron to ASTM A125 Class B, secured to wrought steel stem.

2.2.4.5.5 Seat: integral with body

- 2.2.4.5.6 Stem: wrought steel.
- 2.2.4.5.7 Operator: manual gear
- 2.2.4.5.8 Basis of Design: Crane 461 ½.

2.2.5 Globe Valves:

- 2.2.5.1 Requirements common to globe valves, unless specified otherwise:
 - 2.2.5.1.1 Standard specification: MSS SP-80.
 - 2.2.5.1.2 Bonnet: union with hexagonal shoulders.
 - 2.2.5.1.3 Connections: screwed with hexagonal shoulders.
 - 2.2.5.1.4 Pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - 2.2.5.1.5 Stuffing box: threaded to bonnet with gland follower, packing nut, high grade non-asbestos packing.
 - 2.2.5.1.6 Handwheel: non-ferrous.
 - 2.2.5.1.7 Handwheel Nut: bronze to ASTM B62.
- 2.2.5.2 NPS 2 and under, composition disc, Class 150:
- 2.2.5.3 Body and bonnet: union bonnet.
 - 2.2.5.3.1 Disc and seat: renewable rotating PTFE disc in easily removable disc holder, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
 - 2.2.5.3.2 Operator: handwheel and lockshield.
 - 2.2.5.3.3 Basis of Design: Crane 7TF
- 2.2.5.4 NPS 2 ½ - 10, OSY
- 2.2.5.5 Body: with multiple-bolted bonnet.
 - 2.2.5.5.1 Bonnet-yoke gasket: non-asbestos.
 - 2.2.5.5.2 Disc: Bronze to ASTM B62, fully guided from bottom, securely yet freely connected to stem from swivel action and accurate engagement with disc.
 - 2.2.5.5.3 Seat Ring: Renewable, regrindable, screw into body.
 - 2.2.5.5.4 Stem: bronze to ASTM B62.
 - 2.2.5.5.5 Operator: Manual gear.
 - 2.2.5.5.6 Basis of Design: Crane 351.

2.2.6 Check Valves:

- 2.2.6.1 Requirements common to check valves, unless specified otherwise:
 - 2.2.6.1.1 Standard specification: MSS SP-80.
 - 2.2.6.1.2 Connections: screwed with hexagonal shoulders.
- 2.2.6.2 NPS 2 and under, swing type, bronze disc:
- 2.2.6.3 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - 2.2.6.3.1 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: tetflon.

2.2.6.3.2 Basis of Design: Crane 141 TF

- 2.2.6.4 Swing check valves, NPS 2 ½ - 8 Class 150
- 2.2.6.5 Body and bolted cover: cast iron to ASTM A126 Class b with tapped and plugged opening on each side for hinge pin.
 - 2.2.6.5.1 Flanged ends: 2 mm raised face with serrated finish.
 - 2.2.6.5.2 Disc: rotating for extended life.
 - Up to NPS 3: bronze to ASTM B61.
 - NPS 4-8: Iron faced with ASTM B61 bronze.
 - 2.2.6.5.3 Seat Rings: Renewable bronze to ASTM B61, screwed into body.
 - 2.2.6.5.4 Hinge Pin, bushings: renewable, bronze to ASTM B61
 - 2.2.6.5.5 Hinge: Galvanized malleable iron
 - 2.2.6.5.6 Identification tag: Fastened to cover.
 - 2.2.6.5.7 Basis of Design: Crane 141 TF

2.2.7 Ball Valves:

- 2.2.7.1 NPS 2 and under:
 - 2.2.7.1.1 Body and cap: cast high tensile bronze to ASTM B62.
 - 2.2.7.1.2 Pressure rating: Class 125 2760-kPa CWP 4140-kPa CWP, 860kPa steam.
 - 2.2.7.1.3 Connections: screwed ends to ANSI B1.20.1 and with hexagonal shoulders solder ends to ANSI.
 - 2.2.7.1.4 Stem: tamperproof ball drive.
 - 2.2.7.1.5 Stem packing nut: external to body.
 - 2.2.7.1.6 Ball and seat: replaceable stainless steel hard chrome solid ball and Teflon seats.
 - 2.2.7.1.7 Stem seal: TFE with external packing nut.
 - 2.2.7.1.8 Operator: removable lever handle.

3 EXECUTION

3.1 INSTALLATION

- 3.1.1 Install rising stem valves in upright position with stem above horizontal.
- 3.1.2 Remove internal parts before soldering.
- 3.1.3 Install valves with unions at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.

END OF SECTION

1 GENERAL

1.1 THIS SECTION COVERS ITEMS COMMON TO ALL SECTIONS OF MECHANICAL DIVISIONS (DIVISIONS 21, 23 AND 25).

1.2 REFERENCED SECTIONS

1.2.1 Section 23 01 10 – Mechanical General Requirements

1.2.2 Section 22 05 29 – Bases, Hangers and Supports.

1.2.3 Section 23 25 13 - HVAC Pipe Cleaning and Water Treatment.

1.2.4 Section 23 05 93 – Mechanical Testing, Adjusting and Balancing

1.3 REFERENCE

1.3.1 Canadian General Standards Board (CGSB)

1.3.1.1 CAN/CGSB-1.181-Ready-Mixed Organic Zinc-Rich Coating.

2 PRODUCTS

2.1 NOT USED

3 EXECUTION

3.1 CONNECTIONS TO EQUIPMENT

3.1.1 In accordance with manufacturer's instructions unless otherwise indicated.

3.1.2 Use valves and either unions or flanges for isolation and ease of maintenance and assembly.

3.1.3 Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.

3.2 CLEARANCES

3.2.1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer.

3.2.2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer or as indicated (whichever is greater) without interrupting operation of other system, equipment, and components.

3.3 DRAINS

3.3.1 Install piping with grade in direction of flow except as indicated or specified otherwise.

3.3.2 Install drain valve at low points in piping systems, at equipment and at section isolating valves.

- 3.3.3 Pipe each drain valve discharge separately to above floor drain. Discharge to be visible.
- 3.3.4 Drain valves: NPS 3/4 ball valves unless indicated otherwise, with hose end male thread, cap and chain.
- 3.4 AIR VENTS
 - 3.4.1 Install manual air vents at high points in piping systems.
 - 3.4.2 Install isolating ball valve at each air vent.
- 3.5 DIELECTRIC COUPLINGS
 - 3.5.1 General: Compatible with system, to suit pressure rating of system.
 - 3.5.2 Locations: Where dissimilar metals are joined.
 - 3.5.3 NPS 2 and under: brass adapters or bronze valves.
 - 3.5.4 Over NPS 2: Isolating flanges.
- 3.6 PIPEWORK INSTALLATION
 - 3.6.1 Support piping in accordance with Section 23 05 29.
 - 3.6.2 Screwed fittings to be jointed with Teflon tape.
 - 3.6.3 Protect openings against entry of foreign material.
 - 3.6.4 Install so that equipment can be isolated and removed without interruption to operation of any other equipment or systems.
 - 3.6.5 Assemble piping using fittings manufactured to ANSI standards.
 - 3.6.6 Saddle type branch fittings may be not be used.
 - 3.6.7 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
 - 3.6.8 Install concealed pipework so as to minimize furring space, maximize headroom, conserve space.
 - 3.6.9 Except where indicated otherwise, slope piping in direction of flow for positive drainage and venting.
 - 3.6.10 Except where indicated, install so as to permit separate thermal insulation of each pipe.
 - 3.6.11 Group piping wherever possible.
 - 3.6.12 Ream pipes, remove scale and other foreign material before assembly.
 - 3.6.13 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
 - 3.6.14 Provide for thermal expansion as indicated and specified.

3.6.15 Valves:

- 3.6.15.1 Install in accessible locations.
- 3.6.15.2 Remove interior parts before soldering.
- 3.6.15.3 Install with stems above the horizontal position unless otherwise indicated.
- 3.6.15.4 Valves to be accessible for maintenance without removing adjacent piping.
- 3.6.15.5 Install balancing valves in bypass around control valves where indicated.
- 3.6.15.6 Use isolation valves for shut-off and to isolate equipment, part of systems, branch take-offs, or vertical risers.

3.6.16 Check Valves:

- 3.6.16.1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and elsewhere as indicated.
- 3.6.16.2 Install swing check valves in horizontal lines and elsewhere as indicated.

3.7 SLEEVES

- 3.7.1 General: Install where pipes pass through masonry, concrete structures, fire rated assemblies, and elsewhere as indicated.
- 3.7.2 Material: Schedule 40 black steel pipe.
- 3.7.3 Construction: Foundation walls and where sleeves extend above finished floors - to have annular fins continuously welded on at mid-point.
- 3.7.4 Sizes: 6 mm minimum clearance all round between sleeve and uninsulated pipe or between sleeve and insulation.
- 3.7.5 Installation:
 - 3.7.5.1 Concrete, masonry walls, concrete floors on grade: Terminate flush with finished surface.
 - 3.7.5.2 Other floors: Terminate 25 mm above finished floor.
 - 3.7.5.3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
- 3.7.6 Sealing:
 - 3.7.6.1 Foundation walls and below grade floors: Fire retardant, waterproof non- hardening mastic.
 - 3.7.6.2 Elsewhere: Provide space for firestopping. Maintain fire rating integrity.
 - 3.7.6.3 Sleeves installed for future use: Fill with lime plaster or other easily removable filler.
 - 3.7.6.4 Ensure no contact between copper pipe or tube and sleeve.

3.8 ESCUTCHEONS

- 3.8.1 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.
- 3.8.2 Construction: One piece type with set screws. Chrome or nickel plated brass or type 302 stainless steel.

- 3.8.3 Sizes: Outside diameter to cover opening or sleeve. Inside diameter to fit around pipe or outside of insulation if so provided.
- 3.9 PREPARATION FOR FIRESTOPPING
 - 3.9.1 Material and installation within annular space between pipes, ducts, insulation and adjacent fire separation to Division 07.
 - 3.9.2 Uninsulated unheated pipes not subject to movement: No special preparation.
 - 3.9.3 Uninsulated heated pipes subject to movement: Wrap with non-combustible smooth material to permit pipe movement without damaging firestopping material or installation.
 - 3.9.4 Insulated pipes and ducts: Ensure integrity of insulation and vapour barriers.
- 3.10 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK
 - 3.10.1 Advise Owner 48 hours minimum prior to performance of pressure tests.
 - 3.10.2 Pework: Test as specified in relevant sections of Mechanical Divisions.
 - 3.10.3 Maintain specified test pressure without loss for four 4 hours minimum unless specified for longer period of time in relevant sections of Mechanical Divisions
 - 3.10.4 Prior to tests, isolate equipment and other parts that are not designed to withstand test pressure or media.
 - 3.10.5 Conduct tests in presence of Owner when requested.
 - 3.10.6 Bear costs for repairs or replacement, retesting, and making good. Owner to determine whether repair or replacement is appropriate.
 - 3.10.7 Insulate or conceal work only after approval and certification of tests by Owner.
- 3.11 FLUSHING AND CLEANING OF PIPING SYSTEMS
 - 3.11.1 HVAC piping systems: in accordance with Section 23 25 13.
- 3.12 START-UP OF HYDRONIC SYSTEMS
 - 3.12.1 After cleaning is completed and system is filled:
 - 3.12.1.1 Establish circulation and expansion tank level, set pressure controls.
 - 3.12.1.2 Ensure all air is removed.
 - 3.12.1.3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.
 - 3.12.1.4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.
 - 3.12.1.5 Clean out strainers repeatedly until system is clean.
 - 3.12.1.6 Commission water treatment systems as specified Section 23 25 13.

- 3.12.1.7 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.
- 3.12.1.8 Repeat with water at design temperature.
- 3.12.1.9 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and all other noises.
- 3.12.1.10 Bring system up to design temperature and pressure slowly over a 48 hour
- 3.12.1.11 Perform TAB as specified Section 23 05 93.
- 3.12.1.12 Adjust pipe supports, hangers, springs as necessary.
- 3.12.1.13 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
- 3.12.1.14 Re-tighten all bolts, etc. using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.
- 3.12.1.15 Check operation of drain valves.
- 3.12.1.16 Adjust valve stem packings as systems settle down.
- 3.12.1.17 Fully open all balancing valves (except those that are factory-set).
- 3.12.1.18 Check operation of over-temperature protection devices on circulating pumps.

END OF SECTION

1.1 RELATED REQUIREMENTS

- 1.1.1 This section covers items common to all sections of Mechanical Divisions (Divisions 21, 23 and 25).
- 1.1.2 Section 23 01 10 - Mechanical General Provisions.
- 1.1.3 Section 23 01 20 Mechanical Submittals.

1.2 TAB AGENCY

1.2.1 General:

- 1.2.1.1 All work described in this section to be performed by independent TAB Agency.

1.2.2 Certification:

- 1.2.2.1 Current member in good standing of AABC NEBB, certified to perform specified services.
- 1.2.2.2 Owner to approve within 90 days after award of Contract.
- 1.2.2.3 Submit documentation to confirm qualifications, experience of TAB Agency personnel.

1.2.3 Quality assurance:

- 1.2.3.1 Perform TAB under direction of supervisor qualified by AABC NEBB to standards of NEBB AABC.

1.2.4 Co-ordination:

- 1.2.4.1 Co-ordinate all work specified in this Section.
- 1.2.4.2 Provide all facilities required by TAB Agency in order to carry out work of this Section.

1.2.5 Adequacy of work for TAB:

- 1.2.5.1 TAB Agency to review contract documents before work is started and confirm in writing to Owner adequacy of provisions for TAB and all other aspects of installation pertinent to TAB.

1.2.6 Approved balancing firms: Hydro-Air, Environmetrics, Big Sky Balancing.

1.3 GENERAL

- 1.3.1 TAB: means to test, adjust and balance all systems to perform in accordance with Contract Documents.

- 1.3.2 Follow start-up procedures as recommended by manufacturer unless otherwise specified.
- 1.3.3 Special start-up procedures may be specified elsewhere.
- 1.3.4 Notify Owner 7 days prior to start of TAB.
- 1.3.5 Operate all systems to permit TAB to be performed.
- 1.3.6 TAB to apply to systems, equipment and related controls specified in Mechanical Division.
- 1.3.7 Reference organization standards:
 - 1.3.7.1 Do TAB over entire operating range in accordance with most stringent conditions of this specification and standard of following organization.
 - 1.3.7.1.1 AABC (Associated Air Balance Council).
 - 1.3.7.1.2 NEBB (National Environmental Balancing Bureau).
 - 1.3.7.1.3 SMACNA (Sheet Metal & Air Conditioning Contractors National Association).
 - 1.3.7.1.4 ASHRAE (American Society of Heating, Refrigerating and Air Conditioning Engineers).
- 1.3.8 Start TAB only when building is essentially completed, including:
 - 1.3.8.1 Installation of ceilings, doors, windows and other construction affecting TAB.
 - 1.3.8.2 Application of sealing, caulking and weatherstripping.
 - 1.3.8.3 All pressure, leakage and other tests specified elsewhere in Div. 15 completed.
 - 1.3.8.4 All provisions for TAB are installed and operational.
 - 1.3.8.5 Start-up, verification for proper, safe and normal operation of mechanical and associated electrical and control systems affecting TAB including, but not limited to, the following:
 - 1.3.8.5.1 Proper thermal overload protection in place for electrical equipment.
 - 1.3.8.5.2 Air Systems:
 - Filters in place and in clean condition.
 - Duct systems clean of debris.
 - Air shafts, ceiling plenums are airtight to within specified tolerances.
 - Correct fan rotation.
 - Fire and volume dampers in place and open.
 - Coil fins cleaned and combed.
 - Access doors closed and duct end caps in place.
 - All outlets installed and connected.
 - 1.3.8.5.3 Liquid Systems:
 - Flushed, filled and vented.

- Correct pump rotation.
- Strainer baskets in place and in clean condition.
- Service and balance valves open.
- Liquid treatment system operable.

1.3.9 Accuracy tolerances:

1.3.9.1 Do TAB to following tolerances of design values:

1.3.9.1.1 HVAC systems: Plus 5%; minus 5%.

1.3.9.1.2 Hydronic systems: Plus or minus 10%.

1.3.9.2 As original tolerances.

1.3.9.3 Measurements to be accurate to within plus or minus 2 % of actual values.

1.3.10 Instrument calibration: to be in accordance with TAB referenced organization standard, but within 3 months of commencement of TAB.

1.3.10.1 .1 Provide proof of calibration to Owner.

1.3.11 Submittals prior to commencement of TAB:

1.3.11.1 Proposed methodology and procedures for performing TAB.

1.3.11.2 Proposed check lists and report forms.

1.3.11.3 List of instrumentation, including details and certificates of calibration.

1.3.12 Report:

1.3.12.1 Format to be in accordance with TAB referenced organization standard, but using SI units.

1.3.12.2 Report to include record as built full system schematics showing results of TAB.

1.3.12.3 Submit, prior to formal submission of TAB reports, for checking and approval by Owner, sample of rough TAB sheets. Include:

1.3.12.3.1 Details of instruments used.

1.3.12.3.2 Details of TAB procedures employed.

1.3.12.3.3 Calculations procedures.

1.3.12.3.4 Summaries.

1.3.12.4 Submit 6 copies of TAB reports, each in "D" ring binders, complete with index tabs for verification and approval of Owner.

1.3.13 Verification:

1.3.13.1 Reported measurements shall be subject to verification by Owner. Provide instrumentation and manpower to verify results of up to 30 % of all reported measurements. Number and location of verified measurements to be at discretion of Owner.

1.3.13.2 Bear costs to repeat TAB, as required, to satisfaction of Owner.

1.3.14 Settings: lock and permanently mark settings as required by reference standard.

- 1.3.15 Completion: TAB to be considered complete only when final reports are approved by Owner.

1.4 AIR MOVING SYSTEMS

- 1.4.1 General: measurements as required by referenced organization standards, including, but not limited to, following:

1.4.1.1 Measurements:

- 1.4.1.1.1 Air velocity.
- 1.4.1.1.2 Static pressure.
- 1.4.1.1.3 Velocity pressure.
- 1.4.1.1.4 Temperature:
 - Wet bulb.
 - Dry bulb.
- 1.4.1.1.5 Cross sectional area.
- 1.4.1.1.6 RPM.
- 1.4.1.1.7 Electrical power:
 - Voltage
 - Current draw.
- 1.4.1.1.8 Noise and vibration.

1.4.1.2 Location of equipment measurements:

- 1.4.1.2.1 Inlet and outlet of each:
- Fan.
 - Coil.
 - Filter.
 - Damper.
 - Other auxiliary equipment.

1.4.1.3 Location of system measurements at:

- 1.4.1.3.1 Main ducts.
- 1.4.1.3.2 Main branch ducts.
- 1.4.1.3.3 Sub-branch ducts.
- 1.4.1.3.4 Each supply, exhaust and return air inlet and outlet.
- 1.4.1.3.5 Other auxiliary equipment.
- 1.4.1.3.6 All areas served by system.

1.5 HYDRONIC SYSTEMS

- 1.5.1 General: measurements as required by referenced standards, including, but not limited to, following:

1.5.1.1 Measurements:

- 1.5.1.1.1 Flow.
- 1.5.1.1.2 Pressure.
- 1.5.1.1.3 Temperature.

- 1.5.1.1.4 Specific gravity.
 - 1.5.1.1.5 RPM.
 - 1.5.1.1.6 Electrical power:
 - Voltage.
 - Current draw.
 - 1.5.1.2 Location of equipment measurements:
 - 1.5.1.2.1 Inlet and outlet of each:
 - Heat exchanger (primary and secondary sides).
 - Coil.
 - Boiler.
 - Pump.
 - PRV.
 - Control valve.
 - Make-up (water).
 - Other auxiliary equipment.
 - 1.5.1.3 Location of system measurements at:
 - 1.5.1.3.1 Supply and return of each primary and secondary loop of following hydronic systems:
 - Heating water.
 - 1.5.1.4 Consider glycol systems as hydronic for purposes of this section.
- 1.6 OTHER MECHANICAL SYSTEMS
 - 1.6.1 Plumbing:
 - 1.6.1.1 Flush valves: adjust for proper operation to suit actual site pressure conditions.
 - 1.6.1.2 Domestic water pressure booster systems: adjust pressures for proper operation at all times.
 - 1.6.2 Fire protection systems:
 - 1.6.2.1 .1 To BC Building Code.
- 1.7 BUILDING GENERALLY
 - 1.7.1 Adjust pressure and air flow conditions at exit doors.
 - 1.7.2 Measure DBT, WBT, %RH, air velocity, air flow patterns, and noise data in occupied zone of all occupied areas.

1.8 DOMESTIC HOT WATER RECIRC SYSTEM

1.8.1 General: for purposes of this specification, consider DHW recirc system to be similar to hydronic system and perform TAB accordingly.

1.8.1.1 Location of equipment measurement:

1.8.1.1.1 Inlet and outlet of each:

- Tank.
- Heater.
- Pump.

1.8.1.2 Location of system measurements at each:

1.8.1.2.1 Main.

1.8.1.2.2 Branch main.

1.8.1.2.3 Branch.

1.8.1.2.4 Sub-branch.

END OF SECTION

1 GENERAL

1.1 SUMMARY

1.1.1 Section Includes:

- 1.1.1.1 Materials and methods for pressure testing ducts over 5 m in length, forming part of a supply, return or exhaust ductwork system directly or indirectly connected to air handling equipment.

1.2 REFERENCES

1.2.1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

- 1.2.1.1 Material Safety Data Sheets (MSDS).

1.2.2 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)

- 1.2.2.1 SMACNA HVAC Air Duct Leakage Test Manual, 1985.

1.3 QUALITY ASSURANCE

1.3.1 Pre-Installation Meetings:

- 1.3.1.1 Convene pre-installation meeting one week prior to beginning work of this Section
 - 1.3.1.1.1 Verify project requirements.
 - 1.3.1.1.2 Review installation and substrate conditions.
 - 1.3.1.1.3 Co-ordination with other building subtrades.
 - 1.3.1.1.4 Review manufacturer's installation instructions and warranty requirements.

2 PRODUCTS

2.1 TEST INSTRUMENTS

2.1.1 Test apparatus to include:

- 2.1.1.1 Fan capable of producing required static pressure.
- 2.1.1.2 Duct section with calibrated orifice plate mounted and accurately located pressure taps.
- 2.1.1.3 Flow measuring instrument compatible with the orifice plate.
- 2.1.1.4 Calibration curves for orifice plates used.
- 2.1.1.5 Smoke bombs for visual inspections. (if requested)

2.1.2 Test apparatus: accurate to within +/- 3 % of flow rate and pressure.

3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

- 3.1.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 TEST PROCEDURES

- 3.2.1 Maximum lengths of ducts to be tested consistent with capacity of test equipment.
- 3.2.2 Section of duct to be tested to include:
 - 3.2.2.1 Fittings, branch ducts, tap-ins.
- 3.2.3 Repeat tests until specified pressures are attained. Bear costs for repairs and repetition to tests.
- 3.2.4 Base partial system leakage calculations on SMACNA HVAC Air Duct Leakage Test Manual.
- 3.2.5 Seal leaks that can be heard or felt, regardless of their contribution to total leakage.

3.3 SITE TOLERANCES

- 3.3.1 System leakage tolerances specified are stated as percentage of total flow rate handled by system. Pro-rate specified system leakage tolerances. Leakage for sections of duct systems: not to exceed total allowable leakage.
- 3.3.2 Leakage tests on following systems not to exceed specified leakage rates.
 - 3.3.2.1 Small duct systems up to 250 Pa: leakage 2%.
 - 3.3.2.2 Large low pressure duct systems up to 500 Pa: leakage 2%.
- 3.3.3 Evaluation of test results to use surface area of duct and pressure in duct as basic parameters.

3.4 TESTING

- 3.4.1 Test ducts before installation of insulation or other forms of concealment.
- 3.4.2 Test after seals have cured.
- 3.4.3 Test when ambient temperature will not affect effectiveness of seals, and gaskets.

3.5 TESTED SYSTEMS

3.5.1 The following air systems to be pressure tested:

3.5.1.1 Main supplier air ductwork, 3 locations as directed by the Engineer.

3.5.1.2 Main exhaust air ductwork, 3 locations as directed by the Engineer.

END OF SECTION

1 GENERAL

1.1 REFERENCES

- 1.1.1 ASTM C411-82(1987), Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
- 1.1.2 CAN4-S102-M83, Surface Burning Characteristics of Building Materials and Assemblies.
- 1.1.3 ANSI/NFPA 90A-1985, Air Conditioning and Ventilating Systems, Installation of.
- 1.1.4 ANSI/NFPA 90B-1984, Warm Air Heating and Air Conditioning Systems.
- 1.1.5 CGSB 51-GP-10M-76, Thermal Insulation, Mineral Fibre, Block or Board, for Ducting, Machinery and Boilers.
- 1.1.6 CGSB 51-GP-11M-76, Thermal Insulation, Mineral Fibre, Blanket for Piping, Ducting, Machinery and Boilers.
- 1.1.7 CGSB 51-GP-52M-77, Vapour Barrier Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

1.2 DEFINITIONS

- 1.2.1 For purposes of this section:
 - 1.2.1.1 "CONCEALED" - insulated mechanical services and equipment in hung ceilings and non-accessible chases and furred spaces.
 - 1.2.1.2 "EXPOSED" - will mean "not concealed" as defined herein.

2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- 2.1.1 Insulating Materials: Knauff, Manson, Fibreglas, Manville
- 2.1.2 Adhesives: Armstrong, Childers, Foster, S.Fattal Thermo canvas.
- 2.1.3 Canvas Covering Material: Alpha Maritex, Clairmont Diplag, S. Fattal Thermocanvas.
- 2.1.4 Fasteners: Duro Dyne, Clip Pin.

2.2 GENERAL

- 2.2.1 All components of insulation system to have maximum flame spread rating of 25 and maximum smoke developed rating of 50 in accordance with CAN4-S102.
- 2.2.2 Materials to be tested in accordance with ASTM C411.

- 2.2.3 All mineral fiber insulation to be faced with factory applied foil covering.
- 2.3 D-2 MINERAL FIBER BLANKET WITH VAPOUR BARRIER
 - 2.3.1 Application: on round ducting, either cold or dual temperature:
 - 2.3.1.1 Exhaust air ducts.
 - 2.3.1.2 Combustion air intake ducts.
 - 2.3.1.3 Outside air intake ducts.
 - 2.3.2 Material:
 - 2.3.2.1 CGSB 51-GP-11M, mineral fiber blanket; CGSB 51-GP-52M for vapour barrier.
 - 2.3.3 Thickness:
 - 2.3.3.1 50 mm on intake, combustion, and exhaust ducts
- 2.4 D-4 MINERAL FIBER RIGID WITH VAPOUR BARRIER
 - 2.4.1 Application: on cold or dual temperature rectangular ducting:
 - 2.4.1.1 Exhaust air ducts.
 - 2.4.1.2 Combustion air intake ducts.
 - 2.4.1.3 Outside air intake ducts.
 - 2.4.2 Material:
 - 2.4.2.1 CGSB 51-GP-10M, rigid mineral fiber board; CGSB 51-GP-52M vapour barrier, jacket and facing material.
 - 2.4.3 Thickness:
 - 2.4.3.1 Two 25 mm layers on intake, combustion, and exhaust ducts.
- 2.5 FASTENINGS
 - 2.5.1 Tape: self adhesive, 100 mm wide, aluminum, ULC labelled for less than 25 flame spread and less than 50 smoke developed.
 - 2.5.2 Contact adhesive: quick-setting.
 - 2.5.2.1 Acceptable material: Foster 85-20 asbestos free.
 - 2.5.3 Lap seal adhesive: quick-setting for joints and lap sealing of vapour barriers.
 - 2.5.3.1 Acceptable material: Foster 85-75 asbestos free.
 - 2.5.4 For Canvas:

2.5.4.1 Washable adhesive for cementing canvas lagging cloth to duct insulation.

2.5.4.2 Acceptable material: Foster asbestos free.

2.5.5 Pins.

2.5.5.1 Weld pins 4 mm diameter, with 35 mm diameter head for installation through the insulation. Length to suit thickness of insulation.

2.5.5.2 Acceptable Material: Duro Dyne.

2.5.5.3 Weld pins 2 mm diameter, for installation prior to applying insulation. Length to suit thickness of insulation. Nylon retain clips 32 mm square.

2.5.5.4 Acceptable Material: Duro Dyne pins with spotter clips as required.

2.6 JACKETS

2.6.1 Canvas.

2.6.1.1 Apply in exposed areas indoors: ULC listed plain weave, cotton fabric at 220 g/m².

3 EXECUTION

3.1 APPLICATION

3.1.1 Apply insulation after required tests have been completed and approved by Owner. Insulation and surfaces shall be clean and dry when installed and during application of any finish. Apply insulation materials, accessories and finishes to manufacturer's recommendations and as specified.

3.1.2 Vapour barriers and insulation to be unbroken over full length of duct or surface, without penetration for hangers, standing duct seams and without interruption at sleeves and supports.

3.1.3 Use stand-offs for all duct mounted control accessories.

3.1.4 Apply 1.0 mm thick galvanized sheet metal corners to all ductwork in mechanical rooms.

3.2 INSTALLATION

3.2.1 General:

3.2.1.1 Install in accordance with ANSI/NFPA 90A and ANSI/NFPA 90B.

3.2.1.2 Adhere and seal vapour barrier using vapour seal adhesives.

3.2.1.3 Stagger longitudinal and horizontal joints, on multilayered insulation.

3.2.1.4 Seal all joints and seams in jacketing to ensure weather tight finish on ductwork located outdoors.

3.2.2 Mechanical fastenings:

- 3.2.2.1 On rectangular ducts, use 50% coverage of insulating cement and weld pins at not more than 200 mm centres, but not less than 2 rows per side and bottom.

3.3 SCOPE

- 3.3.1 Completely insulate all ducts listed Part 2 - Products unless otherwise indicated.
- 3.3.2 Insulate outdoor air intakes from outdoors to make-up air and ventilation units.
- 3.3.3 Insulate exhaust ducts for 5 metres back from termination to outdoors.
- 3.3.4 Supply air ducts from ventilation units do not require external insulation.

END OF SECTION

1 General

1.1 SUMMARY

1.1.1 Section Includes:

- 1.1.1.1 Thermal insulation for piping and piping accessories in commercial type applications.

1.2 REFERENCES

1.2.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

- 1.2.1.1 ASHRAE Standard 90.1-01, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).

1.2.2 American Society for Testing and Materials International (ASTM)

- 1.2.2.1 ASTM B209M-04, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate Metric.
- 1.2.2.2 ASTM C335-04, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
- 1.2.2.3 ASTM C411-04, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
- 1.2.2.4 ASTM C449/C449M-00, Standard Specification for Mineral Fiber- Hydraulic-Setting Thermal Insulating and Finishing Cement.
- 1.2.2.5 ASTM C533-2004, Calcium Silicate Block and Pipe Thermal Insulation.
- 1.2.2.6 ASTM C547-2003, Mineral Fiber Pipe Insulation.
- 1.2.2.7 ASTM C795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
- 1.2.2.8 ASTM C921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

1.2.3 Canadian General Standards Board (CGSB)

- 1.2.3.1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- 1.2.3.2 CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts

1.2.4 Department of Justice Canada (Jus)

- 1.2.4.1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.
- 1.2.4.2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
- 1.2.4.3 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

- 1.2.5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - 1.2.5.1 Material Safety Data Sheets (MSDS).
- 1.2.6 Manufacturer's Trade Associations
 - 1.2.6.1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).
- 1.2.7 Underwriters' Laboratories of Canada (ULC)
 - 1.2.7.1 CAN/ULC-S102-03, Surface Burning Characteristics of Building Materials and Assemblies.
 - 1.2.7.2 CAN/ULC-S701-01, Thermal Insulation, Polystyrene, Boards and Pipe Covering.
 - 1.2.7.3 CAN/ULC-S702-1997, Thermal Insulation, Mineral Fibre, for Buildings
 - 1.2.7.4 CAN/ULC-S702.2-03, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.
- 1.3 DEFINITIONS
 - 1.3.1 For purposes of this section:
 - 1.3.1.1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.
 - 1.3.1.2 "EXPOSED" - will mean "not concealed" as specified.
 - 1.3.2 TIAC ss:
 - 1.3.2.1 CRF: Code Rectangular Finish.
 - 1.3.2.2 CPF: Code Piping Finish.
- 1.4 ACTION AND INFORMATIONAL SUBMITTALS
 - 1.4.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
 - 1.4.2 Product Data:
 - 1.4.2.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - 1.4.3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

- 1.4.3.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.5 QUALITY ASSURANCE

1.5.1 Qualifications:

- 1.5.2 Installer: specialist in performing work of this Section and have experience in this size of project.

1.5.3 Health and Safety:

- 1.5.3.1 Do construction occupational health and safety in accordance with Worksafe BC Health and Safety Requirements.

2 Products

2.1 FIRE AND SMOKE RATING

- 2.1.1 In accordance with CAN/ULC-S102.

- 2.1.1.1 Maximum flame spread rating: 25.

- 2.1.1.2 Maximum smoke developed rating: 50.

2.2 INSULATION

- 2.2.1 Mineral fibre specified includes glass fibre, rock wool, slag wool.

- 2.2.2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C mean temperature when tested in accordance with ASTM C335.

- 2.2.3 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.

- 2.2.3.1 Mineral fibre: to CAN/ULC-S702.

- 2.2.3.2 Jacket: to CGSB 51-GP-52Ma.

- 2.2.3.3 Maximum "k" factor: to CAN/ULC-S702.

- 2.2.4 TIAC Code C-2: mineral fibre blanket faced with without factory applied vapour retarder jacket (as scheduled in PART 3 of this section).

- 2.2.4.1 Mineral fibre: to CAN/ULC-S702.

- 2.2.4.2 Jacket: to CGSB 51-GP-52Ma.

- 2.2.4.3 Maximum "k" factor: to CAN/ULC-S702.

- 2.2.5 TIAC Code A-6: flexible unicellular tubular elastomer.

- 2.2.5.1 Insulation: with vapour retarder jacket.

- 2.2.5.2 Jacket: to CGSB 51-GP-52Ma.
- 2.2.5.3 Certified by manufacturer: free of potential stress corrosion cracking
corrodants.

2.3 INSULATION SECUREMENT

- 2.3.1 Tape: self-adhesive, aluminum, plain reinforced, 50 mm wide minimum.
- 2.3.2 Contact adhesive: quick setting.
- 2.3.3 Canvas adhesive: washable.
- 2.3.4 Tie wire: 1.5 mm diameter stainless steel.
- 2.3.5 Bands: stainless steel, 19mm wide, 0.5 mm thick.

2.4 CEMENT

- 2.4.1 Thermal insulating and finishing cement:
 - 2.4.1.1 Air drying on mineral wool, to ASTM C449/C449M.

2.5 VAPOUR RETARDER LAP ADHESIVE

- 2.5.1 Water based, fire retardant type, compatible with insulation.

2.6 JACKETS

- 2.6.1 Polyvinyl Chloride (PVC):
 - 2.6.1.1 One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed
shapes as required.
 - 2.6.1.2 Colours: White
 - 2.6.1.3 Minimum service temperatures: -20°C.
 - 2.6.1.4 Maximum service temperature: 65°C.
 - 2.6.1.5 Moisture vapour transmission: 0.02 perm.
 - 2.6.1.6 Fastenings:
 - 2.6.1.6.1 Use solvent weld adhesive compatible with insulation to seal laps
and joints.
 - 2.6.1.6.2 Tacks.
 - 2.6.1.6.3 Pressure sensitive vinyl tape of matching colour.

3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- 3.1.1 Compliance: comply with manufacturer's written recommendations or specifications,
including product technical bulletins, handling, storage and installation instructions,
and data sheet.

3.2 PRE-INSTALLATION REQUIREMENT

3.2.1 Pressure testing of piping systems and adjacent equipment to become complete, witnessed and certified.

3.2.2 Surfaces clean, dry, free from foreign material.

3.3 INSTALLATION

3.3.1 Install in accordance with TIAC National Standards.

3.3.2 Apply materials in accordance with manufacturers instructions and this specification.

3.3.3 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.

3.3.4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

3.3.4.1 Install hangers, supports outside vapour retarder jacket.

3.3.5 Supports, Hangers:

3.3.5.1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 INSTALLATION OF ELASTOMERIC INSULATION

3.4.1 Insulation to remain dry. Overlaps to manufacturers instructions. Ensure tight joints.

3.4.2 Provide vapour retarder as recommended by manufacturer.

3.5 PIPING INSULATION SCHEDULES

3.5.1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.

3.5.2 TIAC Code: A-3.

3.5.2.1 Securements: Tape at 300 mm on centre.

3.5.2.2 Seals: VR lap seal adhesive, VR lagging adhesive.

3.5.2.3 Installation: TIAC Code: 1501-C.

3.5.3 TIAC Code: A-6.

3.5.3.1 Insulation securements: Glue

3.5.3.2 Seals: lap seal adhesive, lagging adhesive.

3.5.3.3 Installation: TIAC Code: 1501-C

3.5.4 TIAC Code: C-2 with without vapour retarder jacket.

- 3.5.4.1 Insulation securements: Glue.
- 3.5.4.2 Seals: lap seal adhesive, lagging adhesive.
- 3.5.4.3 Installation: TIAC Code: 1501-C.

3.5.5 Thickness of insulation as listed in following table.

- 3.5.5.1 Run-outs to individual units and equipment not exceeding 4000 mm long. Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application	Temp °C	TIAC code	Pipe sizes (NPS) and insulation thickness	1 ¼ to 2	2 ½ to 4	5 to 6	8	Up to 12
Domestic HWS & RECIRC	All	A-1	25mm	25mm	25mm	38mm	38mm	38mm
Domestic CWS (includes soft water)	All	A-3	25mm	25mm	25mm	25mm	25mm	25mm
RWL and RWP	All	25	25mm	25mm	25mm	25mm	25mm	25mm
Steam	All	C-2	50mm	50mm	50mm	50mm	50mm	50mm

- 3.5.6 All rain water leaders concealed in ceiling spaces are to be insulated for 3m from drain or wall discharge.

3.5.7 Finishes:

- 3.5.7.1 Exposed in mechanical rooms: PVC jacket.
- 3.5.7.2 Concealed, indoors: canvas on valves, fittings. No further finish.
- 3.5.7.3 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.
- 3.5.7.4 Installation: to appropriate TIAC code CRF/1 through CPF/5.

END OF SECTION

1 GENERAL

1.1 RELATED REQUIREMENTS

1.1.1 Section 23 01 10 - General Mechanical Provisions.

1.1.2 Section 23 01 20 - Mechanical Submittals.

1.2 REFERENCES

1.2.1 ASTM C411-82(1987), Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.

1.2.2 CAN4-S102-M83, Surface Burning Characteristics of Building Materials and Assemblies.

1.2.3 ANSI/NFPA 90A-1985, Air Conditioning and Ventilating Systems, Installation of.

1.2.4 ANSI/NFPA 90B-1984, Warm Air Heating and Air Conditioning Systems.

1.2.5 CGSB 51-GP-10M-76, Thermal Insulation, Mineral Fibre, Block or Board, for Ducting, Machinery and Boilers.

1.2.6 CGSB 51-GP-11M-76, Thermal Insulation, Mineral Fibre, Blanket for Piping, Ducting, Machinery and Boilers.

1.2.7 CGSB 51-GP-52M-77, Vapour Barrier Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

1.2.8 CAN/CGSB-51.2-M88, Thermal Insulation, Calcium Silicate, for Piping, Machinery and Boilers.

1.2.9 CAN/CGSB-51.12-M86, Cement, Thermal Insulating and Finishing.

1.2.10 CAN/CGSB-51.40-M80, Thermal Insulation, Flexible, Elastomeric, Unicellular, Sheet and Pipe Covering.

1.2.11 CAN/CGSB-51.65-M86, Thermal Insulation, Mineral Fibre, Blanket for D.H.W.Heaters.

1.2.12 ASTM C177-85, Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.

1.3 DEFINITIONS

1.3.1 For purposes of this section:

1.3.1.1 "CONCEALED" - insulated mechanical services and equipment in hung ceilings and non-accessible chases and furred spaces.

1.3.1.2 "EXPOSED" - will mean "not concealed" as defined herein.

2 PRODUCTS

2.1 GENERAL

- 2.1.1 All components of insulation system to have maximum flame spread rating of 25 and maximum smoke developed rating of 50 in accordance with CAN4-S102.
- 2.1.2 Materials to be tested in accordance with ASTM C411.

2.2 ACCEPTABLE MANUFACTURERS

- 2.2.1 Glass fiber Insulating Materials: Fibreglas, Manson, Knauf.
- 2.2.2 Adhesive: Armstrong, Childers, Foster.
- 2.2.3 Canvas Jacket: Alpha - Maritex, Clairmont Diplag, S. Fattal.

2.3 E-1 MINERAL FIBER BLANKET HOT CURVED SURFACES 20 TO 400 DEG.C

2.3.1 Materials:

- 2.3.1.1 CGSB 51-GP-11M, mineral fiber blanket.
- 2.3.1.2 Acceptable material: Fibreglas.

2.3.2 Thermal Conductivity "k" shall not exceed 0.040 W/m.Deg.C at 24 deg.C mean temperature when tested in accordance with ASTM C177.

2.3.3 Applications and thickness:

	<u>Service</u>	<u>Thickness</u>
2.3.3.1	Boiler & water heater breeching	50 mm

2.4 FASTENINGS

- 2.4.1 Tape: self adhesive 100 mm wide.
- 2.4.2 Contact adhesive: quick-setting.
 - 2.4.2.1 Acceptable material: Foster 85-20 asbestos free, 5m sq./L.
- 2.4.3 Lap seal adhesive: quick-setting for joints and lap sealing of vapour barriers.
 - 2.4.3.1 Acceptable material: Foster 85-75 asbestos free, 6 m sq./L.
- 2.4.4 Adhesive for canvas:
 - 2.4.4.1 Washable, for cementing canvas to equipment insulation.

- 2.4.4.2 Acceptable material: Foster 30-36 asbestos free 1.25 m sq./L.
- 2.4.5 Steel wire: 1.5 mm diameter galvanized annealed.
- 2.4.6 Stainless steel wire: 1.5 mm diameter, type 316.
- 2.4.7 Steel bands: 12 x 0.4 mm galvanized steel.
- 2.4.8 Aluminum bands: 12x.6.

2.5 JACKETS

- 2.5.1 Canvas.
 - 2.5.1.1 Application:
 - 2.5.1.1.1 Boiler & water heater breeching.
 - 2.5.1.2 Material: ULC listed, plain weave, cotton fabric, at 220 g/m².
 - 2.5.1.3 Acceptable material: S. Fattal Thermo canvas.

3 EXECUTION

3.1 APPLICATION

- 3.1.1 Apply insulation after all tests have been completed and approved by Owner.
- 3.1.2 Surface to be clean and dry during installation of insulation and finishes.
- 3.1.3 If not specified herein, application to be to manufacturer's recommendations.
- 3.1.4 Maintain uninterrupted integrity of vapour barrier.
- 3.1.5 Apply high density insulation under supports and hangers.

3.2 INSTALLATION

- 3.2.1 Install in accordance with ANSI/NFPA 90A and ANSI/NFPA 90B.
- 3.2.2 Insulation supports where welding or bolting is permitted:
 - 3.2.2.1 Angle anchors: weld or bolt to equipment at lowest point of insulation. Thereafter, locate every 4.5 m vertically.
 - 3.2.2.2 Welded steel clips: at 200 mm maximum on centres, but not less than 2 rows per side.
- 3.2.3 Insulation:
 - 3.2.3.1 Multi-layered: staggered butt joints and expansion joints in insulation, secured with wire or bands at 400 mm on centre intervals.

- 3.2.4 Expansion joints in insulation: leave 25 mm space in each layer at 7 m intervals. Pack space lightly with Type E-1 flexible mineral insulation.
- 3.2.5 Insulation at bolts, studs, nuts, instrumentation: bevel to permit removal without damage to insulation or finish.
- 3.2.6 Fastenings: secure insulation with stainless steel wire galvanized steel wire steel bands aluminum bands at 900 mm on centre before application of finishing cement.
- 3.2.7 Vapour barriers: adhere and seal with vapour seal adhesive.
- 3.2.8 Finishes:
 - 3.2.8.1 Canvas: sewn and pasted on to all insulation and over cement finishes. Seams inconspicuously placed.
 - 3.2.8.2 Final surface: to be clean, smooth, ready for painting.

END OF SECTION

1 General

1.1 REFERENCES

1.1.1 American Society for Testing and Materials International(ASTM)

1.1.1.1 ASTM E202-04, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.2 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS

1.2.1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

1.3 STEAM CONDENSATE SYSTEMS - PERFORMANCE VERIFICATION(PV)

1.3.1 Perform systems performance verification after cleaning is completed and system is in full operation.

1.3.2 When systems are operational, perform following tests:

1.3.2.1 Conduct full scale tests at maximum design flow rates, temperatures and pressures for continuous consecutive period of 48 hours to demonstrate compliance with design criteria.

1.3.2.2 Verify performance of condensate system return pumps as specified, recording system pressures, temperatures, fluctuations by simulating maximum design conditions and varying.

1.3.2.2.1 Pump operation.

1.3.2.2.2 Boiler operation.

1.3.2.2.3 Control pressure failure.

1.3.2.2.4 Maximum heating demand.

1.3.2.2.5 Boiler failure.

1.3.2.2.6 Outdoor reset. Re-check heat exchanger output supply temperature at 100% and 50% reset, maximum water temperature.

1.4 SANITARY AND STORM DRAINAGE SYSTEMS

1.4.1 Ensure that traps are fully and permanently primed.

1.4.2 Ensure that fixtures are properly anchored, connected to system.

1.4.3 Cleanouts: refer to Section 22 42 00 - Plumbing Fixtures.

1.4.3.1 Refer to Section 22 42 00 - Plumbing Fixtures.

1.4.3.2 Remove caps as required.

2 **Products**

2.1 NOT USED

3 **Execution**

3.1 NOT USED

END OF SECTION

1 General

1.1 WORK INCLUDED

- 1.1.1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2 Products

2.1 NOT USED

3 Execution

3.1 INSTALLATION

- 3.1.1 Clean thoroughly all fixtures and equipment from grease, dirt, plaster or any other foreign material. Chrome-plated fittings, piping and trim shall be polished upon completion.
- 3.1.2 Any dirt, rubbish, or grease on walls, floors or fixtures accumulated from the work of the Mechanical Division shall be removed promptly from the premises by this Division.
- 3.1.3 Fixtures and equipment shall be properly protected from damage during the construction period and shall be cleaned and polished in accordance with manufacturer's directions. Motors and equipment bearings shall be protected with plastic sheets, tied or taped in place. Aluminum fin heating or cooling elements shall be protected with cardboard covers.
- 3.1.4 Any unpainted steel surfaces, installed for longer than one year prior to the completion date, shall be prime coated under this Division.
- 3.1.5 During construction protect all services and equipment from dirt and debris, by using temporary caps over the open ends of pipes ductwork and equipment connections.
- 3.1.6 All equipment installed or stored on site shall be maintained in accordance with manufacturers recommended instructions (i.e. rotate shafts on fans, pumps, etc).
- 3.1.7 Refinish and restore to the original condition and appearance all mechanical equipment which has sustained damage to the manufacturer's prime and finish coats of enamel or paint. Materials and workmanship shall be equal to the manufacturers original.

END OF SECTION

1 General

1.1 WORK INCLUDED

- 1.1.1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.1.2 Comply with all requirements of Section 21 05 02.00 – RECORD DRAWINGS.
- 1.1.3 Comply with all requirements of Section 21 05 03.00 – SHOP DRAWINGS.
- 1.1.4 Comply with all requirements of Section 21 08 00.00 – COMMISSIONING.
- 1.1.5 Comply with all requirements of Section 01 78 00 – CLOSEOUT SUBMITTALS.

2 Products

2.1 REQUIREMENTS FOR MANUALS

- 2.1.1 Three copies of complete and approved operating and maintenance instructions for all mechanical equipment and systems shall be supplied before substantial completion. Manuals shall be also submitted in electronic format. Electronic manuals shall be prepared in Adobe PDF format with all sections bookmarked for quick reference and submitted on DVD.
- 2.1.2 Binders shall be three-ring, hard-cover, loose-leaf type and identified on the binding edges as "Maintenance Instructions and Data Book", for this project.
- 2.1.3 Terminology used in all the Sections shall be consistent.
- 2.1.4 Volume One shall contain the master index of all systems, the name of the Contractor, Mechanical Sub-Contractors and the date of substantial performance for the Contract.
- 2.1.5 Volume One shall contain a section with all necessary warranty information.
- 2.1.6 Each binder shall have a complete index for all volumes.
- 2.1.7 Each binder shall be no more than half filled.
- 2.1.8 There shall be a separate section for all materials used on the project which fall under the WHMIS legislation. There shall be a hazard data sheet for each of the materials.
- 2.1.9 There shall be a separate section for all Insurance Certificates, Test Certificates, Verification Forms and Test Forms.
- 2.1.10 All relevant information relating to a system or product shall be contained within one binder.

2.1.11 The manual sections shall follow the specification sections.

2.1.12 Any diagrams, installation drawings, flow charts, etc. shall be mechanically reduced while maintaining full legibility to standard page size. If this cannot be achieved they shall be carefully folded and contained within a clear plastic wallet within the manual.

2.2 DATA FOR MANUALS

2.2.1 Equipment data shall contain:

- 2.2.1.1 Operating instructions
- 2.2.1.2 Operating conditions such as temperature and pressure
- 2.2.1.3 Location of equipment
- 2.2.1.4 Maintenance instructions and schedules for one year routine
- 2.2.1.5 Recommended list of spare parts
- 2.2.1.6 Lubrication schedule
- 2.2.1.7 A trouble shooting table showing where to look for problems under various conditions of malfunction
- 2.2.1.8 All wiring diagrams
- 2.2.1.9 Equipment operating curves
- 2.2.1.10 Equipment nameplate data and serial numbers

2.2.2 System data shall contain:

- 2.2.2.1 A listing of all systems
- 2.2.2.2 A valve schedule and locations
- 2.2.2.3 Equipment name tags
- 2.2.2.4 Filter schedule
- 2.2.2.5 An electric pipe tracing schedule including location and electrical service location
- 2.2.2.6 Cleaning, maintaining and preserving instructions for all material, products and surfaces. Include warnings of harmful cleaning, maintaining and preserving practices.

2.2.3 Sub-Contractor manuals are required for:

- 2.2.3.1 BAS
- 2.2.3.2 Water treatment
- 2.2.3.3 Water and air balancing

2.2.4 As-built documentation shall contain:

- 2.2.4.1 Reviewed As-Built Shop Drawings
- 2.2.4.2 As-Built Construction Drawings
- 2.2.4.3 Originals of Test Forms
- 2.2.4.4 Originals of Test Certificates

2.3 ASSETSPREADSHEET

2.3.1 The Mechanical Contractor shall provide the following information on an excel spreadsheet to be provided by the Landlord:

- 2.3.1.1 Asset Name
- 2.3.1.2 Manufacturer
- 2.3.1.3 Model Number
- 2.3.1.4 Serial Number.

2.3.2 The above information shall be provided for the following mechanical equipment:

- 2.3.2.1 Air conditioningequipment
- 2.3.2.2 boilers and boiler burners
- 2.3.2.3 domestic waterheaters
- 2.3.2.4 forced flow units
- 2.3.2.5 heat exchangers
- 2.3.2.6 fans
- 2.3.2.7 pumps
- 2.3.2.8 tanks
- 2.3.2.9 meters

2.4 OPERATINGINSTRUCTIONS

- 2.4.1 Instruct the Owner's representative in all aspects of the operation and maintenance of systems and equipment.
- 2.4.2 Comply with all requirements of Section 21 08 00.00 – COMMISSIONING, for duration of tests.
- 2.4.3 Instruct the Owner for a minimum of five (5) working days.
- 2.4.4 Arrange for and pay for the services of engineers and other manufacturers representatives required for instruction on the systems and the equipment as requested by the Owner and/or the Owner.

- 2.4.5 At the time of final inspection, provide a sheet for each system and piece of equipment showing the date instructions were given. Each sheet shall show the duration of instruction, name of persons receiving instruction, other persons present (manufacturer's representative, Owner, etc.), system or equipment involved and signature of the Owner's staff stating that they understood the system installation, operating and maintenance requirements. This information shall be inserted in the manuals after all instructions have been completed.
- 2.4.6 Review information with the Owner's representative to ensure that all information required has been provided.
- 2.4.7 Mechanical equipment and systems included in the instruction requirements are:
 - 2.4.7.1 Heating water generators and associated equipment
 - 2.4.7.2 Automatic controls and instrumentation
 - 2.4.7.3 Water treatment and cleaning
 - 2.4.7.4 Life safety and fire protection
 - 2.4.7.5 Noise and vibration
 - 2.4.7.6 Condenser water distribution system
 - 2.4.7.7 Heating water distribution systems
 - 2.4.7.8 Air handling distribution and components
 - 2.4.7.9 Miscellaneous ventilation systems
 - 2.4.7.10 Storm, sanitary and domestic water pumping and distribution system

2.5 TRIAL USAGE

- 2.5.1 The Owner shall be permitted trial usage of systems or parts of systems for the purpose of testing and learning operational procedures. Trial usage shall not affect the warranties nor be construed as acceptance, and no claim for damage shall be made against the Owner for any injury or breakage to any part or parts due to the tests, where such injuries or breakage are caused by a weakness or inadequacy of parts, or by defective materials or workmanship of any kind.

3 Execution

3.1 NOT USED

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

- 1.1.1 Mechanical Systems Starting and Testing: Section 23 01 40
- 1.1.2 Ductwork: Section 23 31 13
- 1.1.3 Ductwork Accessories: Section 23 33 00
- 1.1.4 Air Filters: Section 23 41 13
- 1.1.5 Coils: Section 23 82 10

1.2 REFERENCE DOCUMENTS

- 1.2.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE):
 - 1.2.1.1 ASHRAE 52.2-2077: Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
- 1.2.2 Sheet Metal and Air Conditioning National Contractors Association (SMACNA):
 - 1.2.2.1 SMACNA IAQ: Guideline for Occupied Building Under Construction

1.3 QUALITY ASSURANCE

- 1.3.1.1 The Minister may hire an independent agency to review duct cleaning procedures prior to starting work and perform spot check review of work to determine that duct cleaning has been effectively executed.

1.4 SUBMITTALS

- 1.4.1 Perform duct system cleaning using a firm specializing in this type of work.
- 1.4.2 Submit an outline of the work scope for each air handling system with procedures, equipment, materials and schedule prior to commencing work.
- 1.4.3 Submit a Certificate of Completion stating that duct cleaning [and disinfection] has been completed as specified in this section.

DEFINITIONS

- 1.5
 - 1.5.1 Air system: includes central equipment; supply, return and exhaust fans, coils, dampers, turning vanes, grilles, diffusers, high, medium and low pressure ductwork (supply, return and exhaust) that is associated with an air handling system.

1.6 PROTECTION

- 1.6.1 Protect furniture, equipment and flooring in close proximity to the work area with clean protective coverings.
- 1.6.2 Take precautions to ensure that dust and debris do not spread outside of duct system during the cleaning process.

2 Products

2.1 MATERIALS

- 2.1.1 Temporary Filters: 3 ply filter element to protect equipment during cleaning operation, meeting either of the following:
 - 2.1.1.1 35% dust spot efficiency to ASHRAE 52.1.
 - 2.1.1.2 MERV-8 to ASHRAE 52.2.
- 2.1.2 Access Ports Covers: reusable, positive locking cover for access ports. Maximum flame spread rating of 0. Friction fit plastic plugs and tape are not acceptable access port cover materials.

2.2 ACCESS DOORS

- 2.2.1 Fabricate rigid and close-fitting doors of galvanized steel with sealing gaskets and suitable quick fastening locking devices. Install minimum 25 mm thick insulation with suitable sheet metal cover frame for insulated ductwork.
- 2.2.2 Fabricate with two butt hinges and two sash locks for sizes up to 450 mm, two hinges and two compression latches with outside and inside handles for sizes up to 600 x 1200 mm and an additional hinge for larger sizes.
- 2.2.3 Access doors shall be UL labeled.

3 Execution

3.1 ACCESS DOOR INSTALLATION

- 3.1.1 Install additional access doors required to complete the duct cleaning operations specified in this section.
- 3.1.2 Install 30 mm (maximum) OD access points with covers in the following ductwork locations:
 - 3.1.2.1 At base of all duct risers
 - 3.1.2.2 On both sides of turning vanes in all ducts
 - 3.1.2.3 At each fire damper location
 - 3.1.2.4 On each side of all heating and cooling coils
 - 3.1.2.5 At all locations of internally duct mounted equipment or devices including balancing dampers, automatic dampers, damper motors and controls

3.2 DUCT SYSTEM CLEANING

- 3.2.1 Commence duct system cleaning after completion of ductwork installation and before air handling systems are started.
- 3.2.2 Install temporary filters in the following locations:
 - 3.2.2.1 Behind all grilles and diffusers.
 - 3.2.2.2 In front of all duct coils.
 - 3.2.2.3 At inlet of all terminal high velocity units to protect pitot openings.
- 3.2.3 Clean all ductwork, plenums, coils and air handling equipment with compressed air and mechanical agitation devices or compressed air and high power suction equipment.
- 3.2.4 Do not use mechanical brushes on acoustic lined ductwork.
- 3.2.5 Clean diffusers and grilles.
- 3.2.6 Remove all filters after a settling period of not less than two days or more than five days after vacuum procedure is complete. Ensure the number of filters removed is equal to the number of filters installed.
- 3.2.7 Seal all ductwork outlets and plenum openings with polyethylene sheet cover after duct system has been cleaned.
- 3.2.8 Mark positions of all balancing dampers prior to start of cleaning work, and return dampers to pre-cleaning positions after cleaning has been completed.
- 3.2.9 Repeat duct cleaning procedures on all duct sections found not satisfactory by independent test agency hired by the Minister.

END OF SECTION

1 GENERAL

1.1 REFERENCE STANDARDS

- 1.1.1 CAN4-S102-M83, Surface Burning Characteristics of Building Materials and Assemblies.
- 1.1.2 CGSB 51-GP-9M-76, Thermal Insulation, Mineral Fibre, Sleeving for Piping and Round Ducting.
- 1.1.3 CGSB 51-GP-11M-76, Thermal Insulation, Mineral Fibre, Blanket for Piping, Ducting, Machinery and boilers.
- 1.1.4 CAN/CGSB-51.12-M86, Cement, Thermal Insulating and Finishing.
- 1.1.5 CAN/CGSB-51.40-M80, Thermal Insulation, Flexible, Elastomeric, Unicellular, Sheet and Pipe Covering.
- 1.1.6 CGSB 51-GP-52M-77, Vapour Barrier Jacket and Facing Materials for Pipe, Duct and Equipment Thermal Insulation.
- 1.1.7 CGSB 51-GP-53M-77, Jacketing, Polyvinyl Chloride Sheet for Insulating Pipes, Vessels and Round Ducts.
- 1.1.8 CSA HA Series-M1980, CSA Standards for Aluminum and Aluminum Alloys.
- 1.1.9 ASTM C335-84, Test Method for Steady-State Heat Transfer Properties of Horizontal Pipe Insulations.

1.2 DEFINITIONS

- 1.2.1 For purposes of this of this section:
 - 1.2.1.1 "CONCEALED" - insulated mechanical services and equipment in hung ceilings and non accessible chases and furred spaces.
 - 1.2.1.2 "EXPOSED" - will mean "not concealed" as defined herein.

2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- 2.1.1 Mineral Fibre Insulation Material: Fibreglas, Manson, Knauf, Manville.
- 2.1.2 Adhesives: Armstrong, Foster, Childers.
- 2.1.3 Canvas Jacket: Alpha Maritex, Clairmont, Diplag, S. Fattal Thermocanvas.

2.2 GENERAL

- 2.2.1 All components of insulation system to have maximum flame spread rating of 25 and maximum smoke developed rating of 50 in accordance with CAN4-S102.
- 2.2.2 Material to be tested in accordance with ASTM C411.

- 2.2.3 All glass and mineral fiber insulation material to be factory bonded to an all purpose aluminum foil jacket.
- 2.3 P-1 FORMED MINERAL FIBER
 - 2.3.1 Application: for piping valves and fittings on:
 - 2.3.1.1 Heating water (includes glycol).
 - 2.3.2 Materials:
 - 2.3.2.1 CGSB 51-GP-9M, rigid mineral fiber sleeving for piping.
 - 2.3.3 Thermal conductivity "k" shall not exceed 0.034 W/m. Deg.C at 24 Deg.C mean temperature when tested in accordance with ASTM C335.
 - 2.3.4 Thickness: 25 mm
- 2.4 FASTENINGS
 - 2.4.1 For insulation systems P-1:
 - 2.4.1.1 Tape: self adhesive aluminum, ULC labelled for less than 25 flame spread and less than 50 smoke developed.
 - 2.4.1.1.1 Acceptable material: Fattal Insultape.
 - 2.4.1.2 Lap Seal Adhesive: quick-setting adhesive for joints and lap sealing of vapour barriers.
 - 2.4.1.2.1 Standard of Acceptance: Foster 85-75 asbestos free.
 - 2.4.1.3 Lagging adhesive: fire resistant coating.
 - 2.4.1.3.1 Standard of acceptance: Foster 30-36 asbestos free.
- 2.5 INSULATION CEMENT
 - 2.5.1 To CAN/CGSB-51.12-M86
- 2.6 JACKETS
 - 2.6.1 Canvas
 - 2.6.1.1 Apply in exposed areas: ULC listed plain weave, cotton fabric at 220 g/sq.m.
 - 2.6.1.2 On concealed valves and fittings: ULC listed plain weave cotton fabric at 120 g/sq.m.

3 EXECUTION

3.1 APPLICATION

- 3.1.1 Apply insulation after required tests have been completed and approved by Owner. Insulation and surfaces shall be clean and dry when installed and during application of any finish. Apply insulation materials, accessories and finishes in accordance with manufacturer's recommendations and as specified herein.
- 3.1.2 On piping with insulation and vapour barrier, install high density insulation above hanger shield. Maintain integrity of vapour barrier over full length of pipe without interruption at sleeves, fittings and supports.

3.2 INSTALLATION

- 3.2.1 Install in accordance with ANSI/NFPA 90A and ANSI/NFPA 90B.
- 3.2.2 Preformed: sectional insulation up to NPS 12.
- 3.2.3 Multi-layered: use staggered butt joint construction.
- 3.2.4 Vertical pipe over NPS 3: Insulation supports welded or bolted to pipe directly above lowest pipe fitting. Thereafter, locate on 4.5 m centres.
- 3.2.5 Expansion joints in insulation: terminate single layer and each layer of multiple layers in a straight cut at intervals recommended by manufacturer. Leave void of 25 mm between terminations. Pack void tightly with P-3 flexible mineral insulation.
- 3.2.6 Seal and finish exposed ends and other terminations with insulating cement.
- 3.2.7 Expansion joints in piping: provide for adequate movement of expansion joint without damage to insulation or finishes.
- 3.2.8 Orifice plate mounting flanges, flanges and unions at equipment, expansion joints, valves, other components requiring regular maintenance:
 - 3.2.8.1 on hot piping systems: omit insulation and bevel away from studs and nuts to permit use of tools without damage to insulation or install insulation and finish to permit easy disassembly and replacement without damage to adjacent insulation and finishes.
 - 3.2.8.2 on cold piping systems: insulate all cold surfaces, ensure complete continuity of vapour barrier, and install insulation and finish to permit easy disassembly and replacement without damage to adjacent insulation and finishes.

3.3 FASTENINGS

- 3.3.1 Secure pipe insulation by tape at each end and center of each section, but not more than 900 mm on centers.

3.4 INSULATION SCOPE

- 3.4.1 Unless indicated otherwise, completely insulate all piping, fittings, valves and accessories forming part of and connected to all systems listed generally in Part 2 - Products.

END OF SECTION

1 GENERAL

1.1 RELATED REQUIREMENTS

1.1.1 Section 23 01 10 - Mechanical General Provisions.

1.1.2 Section 23 01 20 - Mechanical Submittals.

1.2 REFERENCES

1.2.1 ANSI B16.5-1981, Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and other Special Alloys.

1.2.2 ANSI B16.18-1984, Cast Copper Alloy Solder Joint Pressure Fittings.

1.2.3 ANSI B16.20-1973, Ring-Joint Gaskets and Grooves for Steel Pipe Flanges.

1.2.4 ANSI B16.21-1978, Non-metallic Flat Gaskets for Pipe Flanges.

1.2.5 ANSI B16.22-1980, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.

1.2.6 ANSI B18.2.1-1981, Square and Hex Bolts and Screws.

1.2.7 ASTM A47M-84, Specification for Ferritic Malleable Iron Castings.

1.2.8 ASTM A53-87b, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.

1.2.9 ASTM A120-84, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated (Galvanized) Welded and Seamless, for Ordinary Uses.

1.2.10 ASTM B32-87, Specification for Solder Metal.

1.2.11 ASTM B75M-86, Specification for Seamless Copper Tube Metric.

1.2.12 CAN/CGA B149.1-00, Natural Gas Installation Code.

1.2.13 CSA W47.1-1983, Certification of Companies for Fusion Welding of Steel Structures.

1.3 PRODUCT DATA

1.3.1 Submit product data in accordance with Section 23 01 20 - Mechanical Submittals.

1.3.2 Indicate on manufacturers catalogue literature following: - valves.

1.4 MAINTENANCE DATA

1.4.1 Provide maintenance data for incorporation into manual specified in Section 23 01 20 - Mechanical Submittals.

2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

2.1.1 Pressure Regulators: Fischer, Singer, Watts.

2.2 PIPE

2.2.1 Steel pipe: to ASTM A120 ASTM A53, Schedule 40, seamless as follows:

2.2.1.1 NPS 1/2 to 2, screwed.

2.2.1.2 NPS 2 1/2 and over, plain end.

2.2.2 Copper tube: to ASTM B75M.

2.3 JOINTING MATERIAL

2.3.1 Screwed fittings: pulverized lead paste.

2.3.2 Welded fittings: to CSA W47.1.

2.3.3 Flange gaskets: to ANSI B16.21 or ANSI B16.20.

2.3.4 Soldered: to ASTM B32, tin antimony 95:5.

2.4 FITTINGS

2.4.1 Steel pipe fittings, screwed, flanged or welded:

2.4.1.1 Malleable iron: screwed, banded, Class 150.

2.4.1.2 Steel pipe flanges and flanged fittings: to ANSI B16.5.

2.4.1.3 Steel butt-welding fittings.

2.4.1.4 Unions: malleable iron, brass to iron, ground seat, to ASTM A47M.

2.4.1.5 Bolts and nuts: to ANSI B18.2.1.

2.4.1.6 Nipples: Schedule 40, to ASTM A53.

2.4.2 Copper pipe fittings, screwed, flanged or soldered:

2.4.2.1 Cast copper fittings: to ANSI B16.18.

2.4.2.2 Wrought copper fittings: to ANSI B16.22.

2.5 VALVES

2.5.1 Provincial Code approved, lubricated plug or ball type.

3 EXECUTION

3.1 PIPING

3.1.1 Install in accordance with applicable Provincial Codes.

- 3.1.2 Install in accordance with CAN1-B149.1-00.
- 3.1.3 Assemble piping using fittings manufactured to ANSI standards.
- 3.1.4 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.
- 3.1.5 Slope piping down in direction of flow to low points.
- 3.1.6 Install drip points:
 - 3.1.6.1 At all low points in piping system.
 - 3.1.6.2 At each connection to equipment.
- 3.1.7 Use eccentric reducers at pipe size change installed to provide positive drainage.
- 3.1.8 Provide clearance for access and for maintenance.
- 3.1.9 Ream pipes, clean scale and dirt, inside and out.
- 3.1.10 Install piping to minimize pipe dismantling for equipment removal.

3.2 VALVES

- 3.2.1 Install valves with stems upright or horizontal unless otherwise approved by Owner.
- 3.2.2 Install valves at all branch take-offs to isolate each piece of equipment, and as indicated.

3.3 TESTING

- 3.3.1 Test system in accordance with CAN1-B149.1-00.

3.4 PURGING

- 3.4.1 Purge after pressure test in accordance with CAN1-B149.1-00.

END OF SECTION

1 GENERAL

1.1 SECTION INCLUDES

1.1.1 Pipe and pipe fittings for:

- 1.1.1.1 Heating water piping system.
- 1.1.1.2 Glycol water piping system.
- 1.1.1.3 Equipment drains and overflows.

1.1.2 Valves:

- 1.1.2.1 Gate valves.
- 1.1.2.2 Globe or angle valves.
- 1.1.2.3 Ball valves.
- 1.1.2.4 Plug valves.
- 1.1.2.5 Check valves.

1.2 RELATED SECTIONS

1.2.1 Section 15012 – Mechanical Submittals

1.3 REFERENCES

- 1.3.1 ASME - Boiler and Pressure Vessel Codes, SEC 9 - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
- 1.3.2 ASME B16.3 - Malleable Iron Threaded Fittings Class 50 and 300.
- 1.3.3 ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- 1.3.4 ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- 1.3.5 ASME B31.9 - Building Services Piping.
- 1.3.6 ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
- 1.3.7 ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- 1.3.8 ASTM B32 - Solder Metal.
- 1.3.9 ASTM B88 - Seamless Copper Water Tube.
- 1.3.10 ASTM F708 - Design and Installation of Rigid Pipe Hangers.
- 1.3.11 AWS A5.8 - Brazing Filler Metal.
- 1.3.12 AWWA C111 - Rubber-Gasket Joints for Ductile Iron and Grey-Iron Pressure Pipe and Fittings.

1.3.13 MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacture.

1.3.14 MSS SP69 - Pipe Hangers and Supports - Selection and Application.

1.3.15 MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.4 SYSTEM DESCRIPTION

1.4.1 Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

1.4.2 Use of grooved mechanical couplings and fasteners is not acceptable.

1.4.3 Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

1.4.4 Use dielectric connections whenever jointing dissimilar metals.

1.4.5 Provide pipe hangers and supports to MSS SP69 unless indicated otherwise.

1.4.6 Use isolation valves for shut-off and to isolate equipment, part of systems, or vertical risers.

1.4.7 Use silent check valves on discharge of pumps.

1.4.8 Use plug valves for throttling and balancing service.

1.4.9 Use ball valves in heating water systems interchangeably with gate valves up to 40 mm.

1.4.10 Use 20 mm ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

1.4.11 Butterfly valves are NOT permitted on all piping.

1.5 SUBMITTALS

1.5.1 Submit to Section 15012.

1.5.2 Welders Certificate: Include welders certification of compliance with ASME SEC 9.

1.5.3 Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.6 PROJECT RECORD DOCUMENTS

1.6.1 Submit to Section 15012.

- 1.6.2 Record actual locations of valves on record drawings.
- 1.7 OPERATION AND MAINTENANCE DATA
 - 1.7.1 Submit to Section 15012.
 - 1.7.2 Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
- 1.8 QUALIFICATIONS
 - 1.8.1 Welders: Certify to ASME SEC 9.
- 1.9 REGULATORY REQUIREMENTS
 - 1.9.1 Conform to ASME B31.9 code for installation of piping system.
 - 1.9.2 Welding Materials and Procedures: Conform to ASME SEC 9 and applicable provincial labour regulations.
 - 1.9.3 Provide certificate of compliance from authority having jurisdiction indicating approval of welders.
- 1.10 DELIVERY, STORAGE, AND HANDLING
 - 1.10.1 Deliver, store, protect and handle products to site to Division One
 - 1.10.2 Accept valves on site in shipping containers with labeling in place. Inspect for damage.
 - 1.10.3 Provide temporary protective coating on cast iron and steel valves.
 - 1.10.4 Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
 - 1.10.5 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.
- 1.11 ENVIRONMENTAL REQUIREMENTS
 - 1.11.1 Do not install underground piping when bedding is wet or frozen.
- 1.12 EXTRA MATERIALS
 - 1.12.1 Provide to Section 15012.
 - 1.12.2 Provide two repacking kits for each size and valve type.

2 PRODUCTS

2.1 HEATING WATER AND GLYCOL PIPING, ABOVE GROUND

2.1.1 Steel Pipe: ASTM A53, Schedule 40, 10 mm wall for sizes 300 mm and over, black.

2.1.1.1 Fittings: ASTM B16.3, malleable iron or ASTM A234, forged steel welding type fittings.

2.1.1.2 Joints: Threaded, or AWS D1.1, welded, flanged with Garlock or Durlon gaskets (no rubber gasket material allowed).

2.1.2 Copper Tubing: ASTM B88, Type L, hard drawn.

2.1.2.1 Fittings: ASME B16.18, cast brass, or ASME B16.22, solder wrought copper.

2.1.2.2 Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 220 to 280 degrees C. Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 640 - 805 degrees C.

2.1.3 PEX-A PIPING AND FITTING

2.1.3.1 Performance Requirements: PEX-a piping and fittings shall meet the following pressure and temperature ratings:

- .1 200 degrees F (93 degrees C) at 80 psi (551 kPa).
- .2 180 degrees F (82 degrees C) at 100 psi (689 kPa).
- .3 73.4 degrees F (23 degrees C) at 160 psi (1,102 kPa).

2.1.3.2 Plastic Pipe and Fittings:

- .1 PEX-a (Engle-method Crosslinked Polyethylene) Piping: Uponor Wirsbo hePEX, ASTM 876 with oxygen-diffusion barrier that meets DIN 4726.
- .2 PEX-a Fittings, Elbows and Tees (1/2 inch through 3 inch nominal pipe size): ASTM F1960 cold-expansion fitting manufactured from the following material types:
 - UNS No. C69300 Lead-free (LF) Brass.
 - 20 percent glass-filled polysulfone as specified in ASTM D6394.
 - Unreinforced polysulfone (group 01, class 1, grade 2) as specified in ASTM D6394.
 - Polyphenylsulfone (group 03, class 1, grade 2) as specified in ASTM D6394
 - Blend of polyphenylsulfone (55-80%) and unreinforced polysulfone (rem.) as specified in ASTM D6394.
 - Reinforcing cold-expansion rings shall be manufactured from the same source as PEX-a piping manufacturer and marked "F1960".

- 2.1.3.3 PEX-a Fittings (1 inch through 4 inch nominal pipe size): SDR9 compression type fitting consisting of a double O-ring insert with a compression sleeve tightened around the pipe and insert.
- 2.1.3.4 Plastic-to-Metal Transition Fittings:
- .1 Manufacturer: Provide fittings from the same manufacturer of the piping.
 - .2 Threaded Brass to PEX-a Transition: One-piece brass fitting with male or female threaded adapter and F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring. Typically used for PEX sizes 3 inch and below.
 - .3 Brass Sweat to PEX-a Transition: One-piece brass fitting with sweat adapter and F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring. Typically used for PEX sizes 3 inch and below.
 - .4 Dezincification-resistant (DZR) Brass to PEX-a Transition: Male NPT thread and PEX compression fitting. Editor: Typically used for PEX sizes 1 inch through 4 inch.
- 2.1.3.5 Plastic-to-Metal Transition Unions:
- .1 Manufacturer: Provide unions from the same manufacturer of the piping.
 - .2 Threaded Brass to PEX-a Union: One-piece brass fitting with male or female threaded adapter and F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring. Typically used for PEX sizes 3 inch and below.
 - .3 Brass Sweat to PEX-a Union: One-piece brass fitting with sweat adapter and F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring. Typically used for PEX sizes 3 inch and below.
- 2.1.3.6 Piping Applications:
- .1 Hot-water heating piping, aboveground (3 inch and below) shall be the following: PEX-a piping, with F1960 cold-expansion fittings.
 - .2 Hot-water heating piping, aboveground (3-1/2 inch through 4 inch) shall be the following: PEX-a piping, with compression fittings.
 - .3 Hot-water heating piping installed below ground and within slabs shall be any of the following:
 - 3 inch and below: Sleeved PEX-a piping with engineered polymer (EP) polyphenylsulfone F1960 cold-expansion fittings. Use the fewest possible joints and install per manufacturer's recommendations.
 - 1 inch through 2 inch: Pre-insulated PEX-a piping with multi-layer, closed-closed cell PEX-foam insulation and a corrugated HDPE jacket with engineered polymer (EP) polyphenylsulfone F1960 cold-expansion fittings. Use the fewest possible joints and install per manufacturer's recommendations.

- 1 inch through 4 inch: Pre-insulated PEX-a piping with multi-layer, closed-cell, PEX-foam insulation and a corrugated HDPE jacket with compression fitting. Use the fewest possible joints and install per manufacturer's recommendations.
- .4 Makeup-water piping, aboveground (3 inch and below) shall be the following: PEX-a piping, with F1960 cold-expansion fittings.
- .5 Makeup-water piping, aboveground (3-1/2 inch through 4 inch) shall be the following: PEX-a piping, with compression fittings.
- .6 Makeup-water piping installed below ground and within slabs shall be any of the following:
 - 3 inch and below: Sleeved PEX-a piping with engineered polymer (EP) polyphenylsulfone F1960 cold-expansion fittings. Use the fewest possible joints and install per manufacturer's recommendations.
 - 1 inch through 2 inch: Pre-insulated PEX-a piping with multi-layer, closed-closed cell PEX-foam insulation and a corrugated HDPE jacket with engineered polymer (EP) polyphenylsulfone F1960 cold-expansion fittings. Use the fewest possible joints and install per manufacturer's recommendations.
 - 1 inch through 4 inch: Pre-insulated PEX-a piping with multi-layer, closed-closed cell PEX-foam insulation and a corrugated HDPE jacket with compression fitting. Use the fewest possible joints and install per manufacturer's recommendations.

2.2 EQUIPMENT DRAINS AND OVERFLOWS

2.2.1 Copper Tubing: ASTM B88, Type L, hard drawn.

2.2.1.1 Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.

2.2.1.2 Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 220 to 280 degrees C.

2.2.2 Steel: ASTM Sch 40, screwed joints.

2.2.3 Plastic.

2.2.4 To suit application.

2.3 PIPE HANGERS AND SUPPORTS

2.3.1 Conform to MSS SP58, MSS SP69 and MSS SP89.

2.3.2 Hangers for Pipe Sizes 13 to 38 mm: Malleable iron or Carbon steel, adjustable swivel, split ring.

2.3.3 Hangers for Cold Pipe Sizes 50 mm and Over: Carbon steel, adjustable, clevis.

- 2.3.4 Hangers for Hot Pipe Sizes 50 to 100 mm: Carbon steel, adjustable, clevis.
- 2.3.5 Hangers for Hot Pipe Sizes 150 mm and Over: Adjustable steel yoke, cast iron roll, double hanger.
- 2.3.6 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

- 2.3.7 Multiple or Trapeze Hangers for Hot Pipe Sizes 150 mm and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
- 2.3.8 Wall Support for Pipe Sizes to 76 mm: Cast iron hook.
- 2.3.9 Wall Support for Pipe Sizes 100 mm and Over: Welded steel bracket and wrought steel clamp.
- 2.3.10 Wall Support for Hot Pipe Sizes 150 mm and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
- 2.3.11 Vertical Support: Steel riser clamp.
- 2.3.12 Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- 2.3.13 Floor Support for Hot Pipe Sizes to 100 mm: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- 2.3.14 Floor Support for Hot Pipe Sizes 150 mm and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
- 2.3.15 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- 2.3.16 Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
- 2.3.17 Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
- 2.4 UNIONS, FLANGES, AND COUPLINGS
 - 2.4.1 Unions for Pipe 50 mm and Under:
 - 2.4.1.1 Ferrous Piping: 1034 kPa malleable iron, threaded.
 - 2.4.1.2 Copper Pipe: Bronze, soldered joints.
 - 2.4.2 Flanges for Pipe Over 50 mm:
 - 2.4.2.1 Ferrous Piping: 1034 kPa forged steel, slip-on.
 - 2.4.2.2 Copper Piping: Bronze.
 - 2.4.2.3 Gaskets: 1.6 mm thick preformed. "Garlock" or "Durlon" brand gasket materials only. Rubber gasket materials not allowed.
 - 2.4.3 Dielectric Connections:
 - 2.4.3.1 Up to 50mm: brass threaded to solder pipe adaptors.
 - 2.4.3.2 Over 50mm: isolating flanges.

2.5 GATE VALVES

2.5.1 Up To and Including 50 mm:

2.5.1.1 Acceptable Material:

2.5.1.1.1 Threaded:

- Crane fig. 438
- Red & White fig.293
- Grinnell fig. 3010.
- Lunkenheimer fig, 2125

2.5.1.1.2 Soldered:

- Crane fig. 1334
- Red & White fig 299
- Grinnell fig. 3010SJ.
- Lunkenheimer fig, 2131

2.5.1.2 Class 125, Bronze body, bronze trim, screwed inside or union bonnet, rising stem, handwheel, inside screw with backseating stem, solid wedge disc, alloy seat rings, threaded or soldered ends.

2.5.2 Over 50 mm – rising stem:

2.5.2.1 Acceptable Material:

2.5.2.1.1 Crane fig. 465 ½ .

2.5.2.1.2 Red & White fig. 421E.

2.5.2.1.3 Grinnell fig. 6020A

2.5.2.1.4 Lunkenheimer fig. 1430

2.5.2.2 Class 125, iron body, bronze trim, bolted bonnet, rising stem, handwheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged ends.

2.5.3 Over 50 mm – non-rising stem:

2.5.3.1 Acceptable Material:

2.5.3.1.1 Crane fig. 461

2.5.3.1.2 Red & White fig.415E.

2.5.3.1.3 Grinnell fig. 6060A.

2.5.3.1.4 Lunkenheimer fig. 1428

2.5.3.2 Class 125, iron body, bronze trim, bolted bonnet, non-rising stem, handwheel, solid wedge disc with bronze seat rings, flanged ends.

2.6 GLOBE OR ANGLE VALVES

2.6.1 Up To and Including 50 mm:

- 2.6.1.1 Acceptable Material:
 - 2.6.1.1.1 Crane fig. 5TF.
 - 2.6.1.1.2 Red & White fig. 220A.
 - 2.6.1.1.3 Grinnell fig. 3210.
 - 2.6.1.1.4 Lunkenheimer fig. 2900.
- 2.6.1.2 Bronze body, bronze trim, union or screwed bonnet, rising stem and handwheel, inside screw with backseating stem, renewable PTFE composition disc and bronze seat, threaded ends.

2.6.2 Over 50 mm:

- 2.6.2.1 Acceptable Material:
 - 2.6.2.1.1 Crane fig. 351.
 - 2.6.2.1.2 Red & White fig. 400A.
 - 2.6.2.1.3 Grinnell fig. 6200A
 - 2.6.2.1.4 Lunkenheimer fig. 1123.
- 2.6.2.2 Iron body, bronze trim, bolted bonnet, rising stem, handwheel, outside screw and yoke, rotating plug-type disc with renewable seat ring and disc, flanged ends.

2.7 BALL VALVES

2.7.1 Up To and Including 40 mm:

- 2.7.1.1 Acceptable material:
 - 2.7.1.1.1 Soldered:
 - Crane fig. CSC 9222
 - Red & White fig. 5049A
 - Grinnell fig. 171S.
 - Lunkenheimer fig. 746FS.
 - 2.7.1.1.2 Threaded:
 - Crane fig. CSC 9202
 - Red & White fig. 5044A
 - Grinnell fig. 171N.
 - Lunkenheimer fig. 746F.
- 2.7.1.2 Bronze two-piece body, full port, chrome plated brass ball, Teflon seats and stuffing box ring, lever handle, soldered or threaded ends.

2.8 PLUG VALVES

2.8.1 Up to 50 mm:

- 2.8.1.1 Manufacturers:
 - 2.8.1.1.1 DeZurik PEC series.
 - 2.8.1.1.2 Grinnell fig. 152
 - 2.8.1.1.3 Keystone figs. 541
- 2.8.1.2 Cast iron body and plug, full port opening, pressure lubricated, Teflon packing, threaded ends.
- 2.8.1.3 Operator: Each plug valve with a wrench with setscrew.
- 2.8.2 Over 50 mm:
 - 2.8.2.1 Manufacturers:
 - 2.8.2.1.1 DeZurik PEC series.
 - 2.8.2.1.2 Grinnell fig. 152
 - 2.8.2.1.3 Keystone figs. 590 & 591
 - 2.8.2.2 Cast iron body and plug, full port opening, pressure lubricated, Teflon packing, flanged ends.
 - 2.8.2.3 Operator: Each plug valve with a wrench with setscrew.
- 2.9 SWING CHECK VALVES
 - 2.9.1 Up To and Including 50 mm:
 - 2.9.1.1 Acceptable materials:
 - 2.9.1.1.1 Threaded:
 - Crane fig. 41TF
 - Toyo fig. 236T.
 - Grinnell fig. 3310.
 - 2.9.1.1.2 Soldered:
 - Red & White fig. 237T.
 - Grinnell fig. 3310SJ.
 - 2.9.1.2 Class 125 bronze body, bronze trim, bronze rotating swing disc, with Teflon composition disc, solder or threaded ends.
 - 2.9.2 Over 50 mm:
 - 2.9.2.1 Manufacturers:
 - 2.9.2.1.1 Crane fig. 373.
 - 2.9.2.1.2 Red & White fig. 435A.
 - 2.9.2.1.3 Grinnell fig. 6300A.
 - 2.9.2.1.4 Lunkenheimer fig. 1790.

- 2.9.2.2 Class 125 iron body, bronze trim, bronze or bronze faced rotating swing disc, renewable disc and seat, flanged ends.

2.10 SILENT CHECK VALVES

2.10.1 50 to 100mm

2.10.1.1 Manufacturers:

2.10.1.1.1 Val Matic 1400 series.

2.10.1.1.2 Grinnell figs. 402 - 404.

- 2.10.1.2 Iron body, bronze trim, in-line wafer style with stainless steel spring, bronze disc and seat, wafer ends.

2.10.2 Over 100 mm

2.10.2.1 Manufacturers:

2.10.2.1.1 Val Matic 1800 series.

2.10.2.1.2 Grinnell figs. 406 - 410.

- 2.10.2.2 Iron body, bronze trim, in-line globe style with stainless steel spring, bronze disc and seat, lug ends.

2.11 GLYCOL CHARGING

- 2.11.1 Fill glycol system with clean diluted water and 50% uninhibited propylene glycol by weight. Pre-mix solution to required proportions before introduction into piping system.

- 2.11.2 Acceptable Material: Dowfrost.

3 EXECUTION

3.1 PREPARATION

- 3.1.1 Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- 3.1.2 Remove scale and dirt on inside and outside before assembly.
- 3.1.3 Prepare piping connections to equipment with flanges or unions.
- 3.1.4 Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- 3.1.5 After completion, fill, clean, and treat systems. Refer to Section 15545

3.2 PRODUCT APPLICATION

- 3.2.1 All piping in mechanical room, pipe riser and heating water pipes 65mm and above shall be cast iron with either welded, thread or groove connection and fitting. Provide separate price to replace above mentioned piping to PEX-a.
- 3.2.2 Heating water pipes for snow melt system to be cast iron.
- 3.2.3 Main and branch piping 50mm and under shall be PEX-a c/w fittings. on floor.
- 3.2.4 All piping in residential suite shall be PEX-a.

3.3 INSTALLATION

- 3.3.1 Install to manufacturer's instructions.
- 3.3.2 Install heating water, glycol to ASME B31.9.
- 3.3.3 Route piping in orderly manner, parallel to building structure, and maintain gradient.
- 3.3.4 Install piping to conserve building space, and not interfere with use of space.
- 3.3.5 Group piping whenever practical at common elevations.
- 3.3.6 Sleeve pipe passing through partitions, walls and floors.
- 3.3.7 Slope piping and arrange to drain at low points.
- 3.3.8 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- 3.3.9 Inserts:
 - 3.3.9.1 Provide inserts for placement in concrete formwork.
 - 3.3.9.2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3.3.9.3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 100 mm.
 - 3.3.9.4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 3.3.9.5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab. Recess nut and plate into slab and grout where flush finish is required.
- 3.3.10 Pipe Hangers and Supports:
 - 3.3.10.1 Install to MSS SP89.
 - 3.3.10.2 Support horizontal piping as scheduled.

- 3.3.10.3 Install hangers to provide minimum 13 mm space between finished covering and adjacent work.
- 3.3.10.4 Place hangers within 300 mm of each horizontal elbow.
- 3.3.10.5 Use hangers with 38 mm minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
- 3.3.10.6 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- 3.3.10.7 Provide copper plated hangers and supports for copper piping.
- 3.3.10.8 Prime coat or cadmium plate exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- 3.3.11 Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 15260.
- 3.3.12 Provide access where valves and fittings are not exposed. Provide access doors to Section 15010 to access through non-accessible ceilings and walls.
- 3.3.13 Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- 3.3.14 Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- 3.3.15 Install valves with stems upright or horizontal, not inverted.

3.4 SCHEDULES

3.4.1 Hanger Rod:

PIPE SIZE (mm)	MAX. HANGER SPACING (m)	ROD DIAMETER (mm)
12 to 32	2	9
38 to 50	3	9
62 to 75	3	13
100 to 150	3	15
200 to 300	4.25	22
350 and Over	6	25
PVC (All Sizes)	1.8	9

- 3.4.2 Valves: provide valves in accordance with the following schedule in each service location described below and in all locations indicated on the drawings.

<u>Service</u>	<u>Valve Type</u>
Equipment isolation	Ball, Gate**
Vertical riser isolation	Ball, Gate**

Branch line isolation	Ball, Gate**
Air vent isolation	Ball
Terminal heat transfer unit isolation	Ball, Gate,
Equipment drains	Ball w/ hose bibb and cap
Riser drains	Ball w/ hose bibb and cap
Terminal heat transfer zone drains	Ball w/ hose bibb and cap
Strainer blowdown drains	Ball w/ hose bibb and cap
Pump discharge check valves	Silent check
Other check valve locations	Swing check
Balancing	Eccentric plug complete with flow venture.
Control valve bypass	Eccentric plug complete with flow venture.

Notes:

** Over 50mm, in mechanical rooms use rising stem valves, outside of mechanical rooms use non-rising stem valves.

END OF SECTION

1 GENERAL

1.1 REFERENCES

- 1.1.1 ASME Section VIII for Unfired Pressure Vessels, 1992.
- 1.1.2 ASTM A 47M-90, Specification for Ferritic Malleable Iron Castings.
- 1.1.3 ASTM A 278M-93, Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 345 °C.
- 1.1.4 ASTM A 516/A 516M-90, Specification for Pressure Vessel Plates, Carbon Steel, for Moderate and Lower Temperature Service.
- 1.1.5 ASTM A 536-84(1993), Specification for Ductile Iron Castings.
- 1.1.6 ASTM B 62-93, Specification for Composition Bronze or Ounce Metal Castings.
- 1.1.7 CSA B51-M95, Boiler, Pressure Vessel, and Pressure Piping Code.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- 1.2.1 Submit shop drawings and product data in accordance with Section 15012 - Mechanical Submittals.
- 1.2.2 Indicate on manufacturers catalogue literature: Expansion tanks, air vents, separators, valves, strainers, flow meters.

1.3 MAINTENANCE DATA

- 1.3.1 Provide maintenance data for incorporation into manual specified in Section 15012 - Mechanical Submittals.

2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- 2.1.1 Expansion tanks: Clemmer, Westeel, ITT, Armstrong.
- 2.1.2 Automatic air vents: Maid-O-Mist, Watts, Armstrong.
- 2.1.3 Air separator: Airtrol, Amtrol, Bell & Gossett, Expanflex, Taco.
- 2.1.4 Pressure relief valves: Bell & Gossett, Singer, Taco, Watts.
- 2.1.5 Pressure reducing valves: Watts, (no equals).
- 2.1.6 Flow meters: Dietrich, Gerand, Presso, Taco, Measurell.

- 2.1.7 Suction diffusers: Armstrong, Bell & Gossett, Taco.
- 2.2 HYDRO – PNEUMATIC TYPE EXPANSION TANK
 - 2.2.1 Horizontal steel expansion tank with separate tapings for all connection indicated on drawings.
 - 2.2.2 Capacity: as indicated.
 - 2.2.3 Size: as indicated.
 - 2.2.4 Working pressure: 860 kPa with ASME stamp and certification.
 - 2.2.5 Air charge to 105 kPa (initial fill pressure of system).
 - 2.2.6 Acceptable material: Clemmer.
- 2.3 AUTOMATIC AIR VENT
 - 2.3.1 Standard float vent: brass body and NPS 1/4 connection and rated at 860 kPa working pressure, installed complete with ball type isolation valves..
 - 2.3.1.1 Acceptable material: Maid-O-Mist.
- 2.4 AIR SEPARATOR - IN-LINE
 - 2.4.1 Working pressure: Cast iron flanged body, internal baffles, threaded top port for industrial air vent connection. Rated at 860 kPa working pressure.
 - 2.4.2 Size: Full line size.
 - 2.4.3 Acceptable material: Taco.
- 2.5 PIPE LINE STRAINER
 - 2.5.1 NPS 2 and under: bronze body to ASTM B 62-93, screwed connections, stainless steel screen with 1.2 mm perforations.
 - 2.5.1.1 Acceptable material: Sarco BT.
 - 2.5.2 NPS 2 to NPS 4: cast iron body to ASTM A 278M-93, Class 30, ANSI 125 flanged connections, stainless steel screen with 1.2 mm perforations.
 - 2.5.2.1 Acceptable material: Sarco CI-125.
 - 2.5.3 NPS 4 and over: cast iron body to ASTM A 278M-93, Class 30, ANSI 125 flanged connections, stainless steel screen with 3.0 mm perforations.
 - 2.5.3.1 Acceptable material: Sarco F-125.

2.5.4 Blowdown connection: NPS 1.

2.5.5 Minimum working pressure: 860 kPa.

2.6 PRESSURE SAFETY RELIEF VALVES

2.6.1 ASME rated, internal spring, external lever, cast brass body, bronze and teflon trim, threaded connections, rated to 1720 kPa working pressure.

2.6.1.1 Acceptable materials: Watts 174A.

2.7 COMBINATION BALANCE VALVE / FLOW METER

2.7.1 NPS 2 and under:

2.7.1.1 Class 125, 860 kPa, brass body, chrome-plated brass ball, teflon seat and stem seals, fixed calibrated brass orifice meter, memory locking device, differential pressure measurement ports, metal tag identification tag showing orifice size, location, flow rate, and pressure differential.

2.7.1.2 Acceptable material: Gerand Balvalve-Indicator.

3 EXECUTION

3.1 GENERAL

3.1.1 Install as indicated and to manufacturer's recommendations.

3.1.2 Pipe drains and blow off connections to above nearest drain, glycol to be piped to glycol storage tank.

3.1.3 Maintain proper clearance to permit service and maintenance.

3.1.4 Should deviations beyond allowable clearances arise, request and follow Owner's directive.

3.1.5 Check shop drawings for conformance of all tapings for ancillaries and for equipment operating weights.

3.2 STRAINERS

3.2.1 Install in horizontal or down flow lines.

3.2.2 Ensure clearance for removal of basket.

3.2.3 Install ahead of each pump and as indicated.

3.2.4 Install ahead of each automatic control valve larger than NPS 1 except at radiation and as indicated.

3.3 AIR VENTS

3.3.1 Install at high points of systems.

3.3.2 Install ball valve on automatic air vent inlet.

3.4 EXPANSION TANKS

3.4.1 Adjust expansion tank pressure to ensure minimum positive pressure of 30 Kpa at highest elevation.

3.5 PRESSURE SAFETY RELIEF VALVES

3.5.1 Provide at all locations required by applicable codes and to the requirements of the authorities having jurisdiction.

3.5.2 Pipe discharge to above nearest drain; glycol system to be piped to glycol storage tank.

3.6 FLOW MEASURING STATION

3.6.1 Up to and including 50mm:

3.6.1.1 Install combination balance valve/flow meter as specified in part 2.

3.6.2 Above 50mm:

3.6.2.1 Install in series with all balancing valves at locations indicated on drawings and specified in Section 15413 - Piping, Valves & Fittings - Hydronic.

3.6.3 Install to manufacturers instructions and in accordance with the following: Install flow measuring elements a minimum of 10 straight pipe diameters upstream and 3 pipe diameters downstream of elbows. Flow straightening vanes may be used to reduce these clearances if installed in accordance with the manufacturer's instructions.

3.6.4 Where the available straight pipe length does not permit the installation of a Venturi flow measuring element, an elbow flow meter may be used in its place.

3.7 AIR SEPARATORS

3.7.1 Install on each closed loop piping system on main line near discharge of circulation pump.

END OF SECTION

1 GENERAL

1.1 RELATED REQUIREMENTS

1.1.1 Section 23 01 10 - Mechanical General Requirements.

1.1.2 Section 23 01 20 - Mechanical submittals.

1.2 REFERENCES

1.2.1 ASTM A53-90b, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.

1.2.2 ASTM A105/A105M-91, Specification for Forgings, Carbon Steel, for Piping Components.

1.3 PRODUCT DATA

1.3.1 Submit product data in accordance with Section 23 01 20 - Mechanical Submittals.

1.3.2 Indicate for each item as applicable:

1.3.2.1 Manufacturer, model number, line contents, pressure and temperature rating.

1.3.2.2 Movement handled; axial, lateral, angular and the amounts of each.

1.3.2.3 Nominal size and dimensions including details of construction and assembly.

1.4 MAINTENANCE DATA

1.4.1 Provide maintenance data for incorporation into manual specified in Section 23 01 20 - Mechanical Submittals.

1.4.2 Data to include:

1.4.2.1 Servicing requirements, including any special requirements, stuffing box packing, lubrication and recommended procedures.

2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

2.1.1 Flexible Connections: Annaconda, Badger, Flexonics, Flexpipe, United, Mueller.

2.2 FLEXIBLE CONNECTION

2.2.1 Application: to suit motion as indicated.

2.2.2 Minimum length in accordance with manufacturer's recommendations to suit offset as indicated.

- 2.2.3 Inner hose: stainless steel corrugated.
- 2.2.4 Braided wire mesh stainless steel outer jacket.
- 2.2.5 Diameter and type of end connection: as indicated.
- 2.2.6 Operating conditions:
 - 2.2.6.1 Working pressure: 1034 kPa.
 - 2.2.6.2 Working temperature: 93 203 deg.C.
 - 2.2.6.3 To match system requirements.
- 2.2.7 Acceptable materials: Flexonics.

3 EXECUTION

3.1 INSTALLATION

- 3.1.1 Install expansion joints with cold setting, as indicated as instructed by Owner. Make record of cold settings.
- 3.1.2 Install expansion joints and flexible connections in accordance with manufacturer's instructions.
- 3.1.3 Install pipe anchors and guides as indicated. Anchors to withstand 150% of axial thrust.

END OF SECTION

1 GENERAL

1.1 RELATED REQUIREMENTS

1.1.1 Section 23 01 10 - Mechanical General Requirements.

1.1.2 Section 23 01 20 - Mechanical Submittals.

1.1.3 Section 23 05 93 - Testing Adjusting and Balancing.

1.2 SHOP DRAWINGS AND PRODUCT DATA

1.2.1 Submit shop drawings and product data in accordance with Section 23 01 20 - Mechanical Submittals.

1.2.2 Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories and controllers.

1.2.3 Submit product data of pump curves for review showing point of operation.

1.2.4 Indicate piping, valves and fittings shipped loose by packaged equipment supplier, showing their final location in field assembly.

1.3 MAINTENANCE DATA

1.3.1 Provide maintenance data for incorporation into manual specified in Section 23 01 20 - Mechanical Submittals.

1.4 MAINTENANCE MATERIALS

1.4.1 Provide maintenance materials in accordance with Section 23 01 20 - Mechanical Submittals.

1.4.2 Furnish following spare parts: one set of pump seals for each pump type.

2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

2.1.1 Base Mounted Pumps: Armstrong, Bell & Gossett, Taco, Myers.

2.1.2 Vertical Inline Pumps: Armstrong, Bell & Gossett, Taco, Myers.

2.2 VERTICAL IN-LINE CIRCULATORS

2.2.1 Volute: cast iron radially split, with tapped openings for venting, draining and gauge connections, with screwed or flanged suction and discharge connections.

- 2.2.2 Impeller: brass or bronze.
- 2.2.3 Shaft: stainless steel with bronze sleeve bearing, integral thrust collar.
- 2.2.4 Seal assembly: mechanical for service to 135 Deg.C.
- 2.2.5 Coupling: rigid self-aligning.
- 2.2.6 Motor: resilient mounted, drip proof, sleeve bearing, 1750 r/min, kW as indicated.
- 2.2.7 Capacity: as indicated.
- 2.2.8 Design pressure: 1200 kPa.
- 2.2.9 Acceptable Material: Armstrong.

2.3 SINGLE SUCTION BASE MOUNTED CENTRIFUGAL PUMP

- 2.3.1 General: bronze fitted cast steel pump complete with motor.
- 2.3.2 Base: common cast iron or fabricated steel with drip rim and tapping for drain connection.
- 2.3.3 Volute: bronze, radially split, end suction, flanged suction and discharge, with drain plug and vent cock, suction and discharge pressure gauge tappings.
- 2.3.4 Impeller: bronze, enclosed type, keyed drive with locking nut or screw.
- 2.3.5 Shaft: stainless steel with two point support, machined shoulders for ball bearing mounting.
- 2.3.6 Seal assembly: mechanical lubricated.
- 2.3.7 Coupling: flexible self-aligning.
- 2.3.8 Motor: EEMAC Class B, squirrel cage induction, 1,725 r/min. continuous duty, drip proof, ball bearing, maximum temperature rise 50°C.
- 2.3.9 Capacity: as indicated.
- 2.3.10 Design pressure: 1200 kPa.
- 2.3.11 Acceptable material: Armstrong.

3 EXECUTION

3.1 INSTALLATION

- 3.1.1 In-line Circulators: install as indicated by flow arrows. Support at inlet and outlet flanges or unions. Install with bearing lubrication points accessible.

- 3.1.2 Ensure that pump body does not support piping or equipment. Provide stanchions or hangers for this purpose. Refer to manufacturer's installation instructions for details.
- 3.1.3 Pipe drain tapping to floor drain.
- 3.1.4 Install volute venting pet cock in accessible location.
- 3.1.5 Check rotation prior to start-up.
- 3.1.6 Install pressure gauge test cocks.
- 3.1.7 Base mount pumps to come complete with suction diffuser.

END OF SECTION

1 General

1.1 WORK INCLUDED

- 1.1.1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2 Products

2.1 MATERIALS

- 2.1.1 All pressure relief valves shall be code rated for the service and shall be approved under Canadian Interprovincial Boiler Inspection Regulations.
- 2.1.2 Pressure relief valves shall be Spirax Sarco or approved equal.

3 Execution

3.1 INSTALLATION

- 3.1.1 Relief valve on hot water heating system shall operate at (pressure shown) 207 kPa (30 psi) pressure unless noted otherwise.

END OF SECTION

1 GENERAL

1.1 REFERENCES

- 1.1.1 ANSI/ASME Boiler and Pressure Vessel Code, Section VII-1992.

1.2 SHOP DRAWINGS

- 1.2.1 Submit shop drawings in accordance with Section 15012 - Mechanical Submittals.
- 1.2.2 Indicate the following: Equipment, and schematic hook up, degreasing and cleaning material and methods, and chemical treatment materials.

1.3 OPERATIONS AND MAINTENANCE DATA

- 1.3.1 Provide operation and maintenance data for incorporation into manual specified in Section 15012 - Mechanical Submittals.
- 1.3.2 Include following:
 - 1.3.2.1 Log sheets as recommended by manufacturer for review.

1.4 CERTIFICATION

- 1.4.1 Submit written reports to the Owner containing results of tests taken every seven days after completion of chemical treatment. Reports shall be done every seven days for a minimum period of 35 days.
- 1.4.2 Chemical Treatment Agency to provide monthly site visits (12 minimum) within the warranty year to check the treatment, take samples, analyze and recommend proper addition of treatment. Provide written reports to the Owner after each site visit with a copy to the Owner.

1.5 GENERAL REQUIREMENTS

- 1.5.1 Obtain the services of a qualified owner specializing in system cleaning, chemical treatment, chemical feed equipment, and professional services:
 - 1.5.1.1 Supervise all cleaning procedures and chemical additives.
 - 1.5.1.2 Draw samples from each particular system and submit samples to Owner/Owner for final approval at the following stages:
 - 1.5.1.2.1 Cleaner in
 - 1.5.1.2.2 Final flush
 - 1.5.1.2.3 Treated water final
 - 1.5.1.3 Instruct the Owner in the application and control of all phases of the water treatment programs including testing procedures and interpretation.

- 1.5.1.4 Provide periodic written reports indicating the status of each system before final acceptance.
- 1.5.1.5 Provide all necessary documentation of products and equipment to comply with all relevant WHMIS and OHAS regulations.
- 1.5.2 All MSDS must clearly state all components of the products supplied. MSDS showing only hazardous materials shall be considered as incomplete.
- 1.5.3 Maintenance data for water treatment equipment for incorporation into maintenance manual shall be provided.
- 1.5.4 One year supply of chemical for each system and softener salt shall be provided.
- 1.5.5 For each type of system one set of basic test equipment complete with carrying case and reagents for chemicals supplied shall be provided. Required specialized or supplementary equipment shall be included.

2 PRODUCTS

2.1 CHEMICAL TREATMENT AGENCY

- 2.1.1 Chemical Treatment Agency shall provide all permanently installed equipment, chemicals, instruction, site supervision, testing and certification services so as to fully comply with the intent of this specification section.
- 2.1.2 Acceptable Chemical Manufacturer: G.E. Betz Water Technologies, Gardian –IPCO.
- 2.1.3 Acceptable Agency: Specified Technical Sales Ltd. (no equals)

2.2 POT FEEDER

- 2.2.1 Welded steel: Pressure rating: 1400 kPa. Temperature rating: 120EC

2.3 CHEMICAL FEED PIPING

- 2.3.1 Schedule 80, black steel.

2.4 TANKS

- 2.4.1 Polyethylene: high density, moulded, with liquid level graduations, cover and stainless steel stand.

2.5 CLOSED LOOP HYDRONIC HEATING SYSTEMS

- 2.5.1 Closed Water System Chemical Feed Equipment

- 2.5.1.1 Hot water heating, and glycol systems to have a bypass pot feeder installed across the circulation pump. Feeder shall have a minimum capacity of 7.6 litres (2 Imp. Gallons) and be of steel construction with a working pressure of 1035 kPa (150 psig). Feeder shall be complete with valve kit containing isolating valves, drain valve, and air venting valve.
 - 2.5.1.2 Hot water heating, and glycol systems to have an "in-line" filter for removal of particulate matter. Filter cartridges are to be of the 10 micron rating, 30 of which are to be supplied. A petcock shall be installed for pressure relief of the canister for filter replacement. A sight flow indicator shall be installed to determine filter condition.
 - 2.5.1.3 The filter canister shall be a 20 mm (3/4") AMF Cuno CT101 or equal.
 - 2.5.1.4 Filter and flow indicator shall be installed in an accessible location and not more than 1.5 m (60") above floor level.
- 2.5.2 Closed Water System Chemicals
 - 2.5.2.1 Provide sufficient molybdate-amine based corrosion inhibitor to achieve and inhibitor level of 100 ppm (as molybdenum).
- 2.5.3 Glycol Water Treatment Equipment
 - 2.5.3.1 Provide 135 litres (30 IG) polyethylene reservoir tank on each glycol system.
 - 2.5.3.2 Provide 110 V, 1/2 HP gear pump for each glycol system to facilitate the transfer of glycol from the reservoir tank to the system.
 - 2.5.3.3 Glycol used shall be a premixed (50/50) blend of distilled water and uninhibited propylene glycol.
- 2.6 SUPPLY OF CHEMICALS
 - 2.6.1 Provide one year supply. Chemicals to be compatible with each type of system specified.
 - 2.6.2 Provide 66 litres of Optiguard MCM 4280 for steam humidification system.
- 2.7 TEST EQUIPMENT
 - 2.7.1 Provide, for each type of system specified herein, one set of basic test equipment complete with carrying case and reagents for chemicals supplied. Include required specialized or supplementary equipment.
- 2.8 TANKS
 - 2.8.1 Polyethylene: high density, moulded, with liquid level graduations, cover and stand.

3 EXECUTION

3.1 GENERAL APPLICATION

- 3.1.1 Install HVAC water treatment systems in accordance with ASME Boiler Code Section VII, and requirements and standards of authorities having jurisdiction, except where specified otherwise.
- 3.1.2 Ensure adequate clearances to permit performance of servicing and maintenance of equipment.
- 3.1.3 Application of pipe cleaning chemicals and cleaning procedures shall be done by Mechanical trade under direct supervision of chemical treatment supplier.
- 3.1.4 Repeat flush cycles described herein as many times as necessary or whatever part of cycle is deemed necessary by Owner if system fluid and strainers indicates that the system is dirty during Warranty Period.
- 3.1.5 Piping systems and connected products damaged or fouled as a result of operating systems before chemical cleaning shall be replaced or cleaned without cost to Owner.

3.2 WATER TREATMENT SERVICES

- 3.2.1 Provide water treatment monitoring and consulting services for period of one year after system start-up. Service to include:
 - 3.2.1.1 Initial water analysis and treatment recommendations.
 - 3.2.1.2 System start-up assistance.
 - 3.2.1.3 Operating staff training.
 - 3.2.1.4 Visit plant every 5 days during period of operation and as required until system stabilizes, and advise on treatment system performance.
 - 3.2.1.5 Provide necessary recording charts and log sheets for one year operation.
 - 3.2.1.6 Provide necessary laboratory and technical assistance.
 - 3.2.1.7 Instructions and advice to operating staff to be clear, concise and in writing.

3.3 BASIC REQUIREMENTS

- 3.3.1 Application of pipe cleaning chemicals and cleaning procedures shall be carried out by Mechanical trade under direct supervision of chemical treatment supplier.
- 3.3.2 Repeat flush cycles described herein as many times as necessary or whatever part of cycle is deemed necessary by Owner if system fluid and strainers indicates that the system is dirty during Warranty Period.
- 3.3.3 Piping systems and connected products damaged or fouled as a result of operating systems before chemical cleaning shall be replaced or cleaned without cost to Owner.

3.4 CLOSED LOOP HYDRONIC SYSTEM CLEANING PROCEDURE

- 3.4.1 Chemically clean equipment in accordance with manufacturer's printed installation instructions.
- 3.4.2 Remove or bypass all control valves during cleaning and flushing.
- 3.4.3 Meter system volume during fill and report volume to Owner and Owner.
- 3.4.4 Chemically clean piping system in the following order.
 - 3.4.4.1 Before commencing with Stage I cleaning procedure:
 - 3.4.4.1.1 Open system flush valves.
 - 3.4.4.1.2 Isolate system from connected products by opening manual by-pass valves around connected products and closing their manual supply valves, by placing control valves in by-pass position, and by valving off pressure gauges/automatic fill valves/reliefs.
 - 3.4.4.1.3 Strainers/filters by-passes shall be in place.
 - 3.4.4.2 Stage I cleaning procedure:
 - 3.4.4.2.1 Fill system with cold water cleaning compound. Circulate in accordance with manufacturer's printed instructions (minimum 72 hours).
 - 3.4.4.2.2 Periodically purge system low points and clean strainer/filter by-pass screens of accumulations.
 - 3.4.4.2.3 Drain system after this mixture has been circulated through system for prescribed time period.
 - 3.4.4.2.4 Purge system low points and clean strainer/filter bypass screens.
 - 3.4.4.2.5 Commence immediately with Stage II cleaning after Stage I cleaning procedure is complete.
 - 3.4.4.3 Before commencing with Stage II cleaning procedure:
 - 3.4.4.3.1 Close system flush valves.
 - 3.4.4.3.2 Open system to connected products except for pressure gauges/automatic air vents/automatic fill valves/reliefs.
 - 3.4.4.4 Stage II cleaning procedure:
 - 3.4.4.4.1 Fill system with hot water and hot water cleaning compound.
 - 3.4.4.4.2 Circulate continuously in accordance with manufacturer's printed instruction (minimum 72 hours).
 - 3.4.4.4.3 Periodically purge system low points and strainer/filter bypass screens of accumulations.

- 3.4.4.4.4 Open drains and flush out solution with raw water after this mixture has been circulated through system for prescribed period.
 - 3.4.4.4.5 Clean strainer/filter screens, sediment pockets, pump casings after final flushing.
 - 3.4.4.4.6 Discard the start-up strainers after final flushing and replace with permanent screens.
 - 3.4.4.4.7 Remove several remote valves at random after system cleaning for checking system cleanliness.
 - 3.4.4.4.8 Repeat Stage II cleaning procedure if system is still dirty.
 - 3.4.4.4.9 Open up pressure gauge shut-off valves, automatic air vents, automatic fill valves, reliefs after system is accepted as clean.
- 3.4.4.5 No system shall be drained down and remain empty once filled with water. Refill systems immediately after systems are judged clean by chemical supplier and add corrosion inhibiting chemicals.

END OF SECTION

1 General

1.1 WORK INCLUDED

- 1.1.1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2 Products

2.1 MATERIALS

- 2.1.1 Provide pipe system filters equal to Ashland Drew Micron Medium Flow Filters Series 9240/ 9241 or GE W&P Technologies 3CMC/6CMC.
- 2.1.2 Shell and heads shall be suitable for 1035 kPa (150 psi) working pressure and filter media shall be suitable for 149 deg. C. (300 deg. F.) service temperature.
- 2.1.3 Filter media shall be bleached cotton for selective removal of particles from 1 to 100 microns. Media shall be non-rupturing and mounted so that no by-pass of media shall occur. Filters shall be equal to Ashland Drew PN 9236 or Viper VPYC.
- 2.1.4 Filters shall be sized for 3% of total system flow and shall be within the mid-capacity of the filter operating flow rate.
- 2.1.5 Pipe system filters shall be installed in the following systems:
 - 2.1.5.1 Perimeter heating systems
 - 2.1.5.2 Constant temperature heating system

3 Execution

3.1 INSTALLATION

- 3.1.1 Install pipe system filters across the pumps with valved inlet and outlet. Outlet valve shall be a flow balancing valve. Refer to Section 23 21 13.23 – PIPES, VALVES AND FITTINGS (EXCEPT PLUMBING). Provide flanges or unions for servicing. Provide valved drain on unit casing.

END OF SECTION

1 General

1.1 WORK INCLUDED

1.1.1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 SUBMITTALS

1.2.1 Shop Drawings: Submit Shop Drawings of all chemicals used in the system in accordance with SECTION 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2 Products

2.1 MATERIALS

2.1.1 Water piping cleaning solution for closed loop systems shall be equal to GE W&P Technologies FERROQUEST FQ7103 or Ashland Drew CSW 600. Refer to manufacturers instructions for chemical concentrations.

2.1.2 Boiler system cleaning formulation shall be equal to GE W&P Technologies OPTISPERSE ADJ0346 or Ashland Drew LAC PN 0057-40-7. Refer to manufacturers instructions for chemical concentrations.

2.1.3 Ethylene glycol system solution shall be 50% by volume of factory, pre-mixed solution of inhibited ethylene glycol. Ethylene glycol shall be Dow Chemical Co. "Dowtherm SR-1", Interstat Chemical Co. "Intercool NFE", or Recochem Inc. "Recotherm IG"..

2.1.4 Propylene glycol system solution shall be 50% by volume of factory, pre-mixed solution of inhibited propylene glycol. Propylene glycol shall be Dow Chemical Co "Dowfrost", Interstat Chemical Co. P-323" or Recochem Inc. "Recofreeze PG".

3 Execution

3.1 INSTALLATION

3.1.1 All systems shall have been hydrostatically tested prior to cleaning.

3.1.2 Thoroughly flush all systems with raw water to remove loose mill scale and debris. Remove and clean all strainers and flush low points before chemical cleaner is added.

3.1.3 All coils shall be disconnected and flow shall be by-passed.

3.1.4 A temporary pump shall be installed in the system and shall be capable of pumping adequate discharge at adequate head.

3.1.5 A temporary heater shall be installed in the system and shall be capable of maintaining the circulating water temperature as required for chemical treatment.

- 3.1.6 Systems shall be filled with city water and approved chemical cleaner introduced by a small temporary chemical injector pump at the temporary circulating pump section. Cleaner shall be introduced to maintain concentrations as per the manufacturer's recommendations.
- 3.1.7 All systems shall be cleaned in accordance with manufacturer's instructions and under the supervision of the chemical supplier's representative. Minimum cleaning procedures shall be to fill all water piping cleaning solution, circulate at 1.5 times specified system flow rate and maintain at highest possible temperature for 72 hours. During this period heavy blowdown of all low points shall be carried out every 6 hours. Strainers shall be cleaned as necessary to permit maximum flow possible and, in any event, at least every 6 hours. Drain the solution, all strainers, and flush entire system with clean water for a minimum of 24 hours. Repeat fill and flush procedure as often as required, adding inhibitor with each fill, to achieve acceptable contaminant levels. Systems shall then be refilled, ready for use. Temperature of system for cleaning shall be to suit chemical supplier's requirements.
- 3.1.8 Take samples of system from a series of representative drains as directed by the Owner. If system is still dirty repeat cleaning procedure specified above until acceptable. Acceptable samples shall indicate that alkalinity and pH have returned to potable water levels. Copies of all test reports shall be submitted by the water treatment supplier to the Owner for verification prior to final filling.
- 3.1.9 Add chemical treatment immediately after cleaning has been completed and accepted. Acceptable control parameters shall be as follows:
 - 3.1.9.1 Nitrite: 1000 – 1500 ppm
 - 3.1.9.2 pH: 8.5 – 10
 - 3.1.9.3 Iron: Less than 2.0 ppm
 - 3.1.9.4 Copper: Less than 0.3 ppm
 - 3.1.9.5 Molybdate: 100 – 150 ppm
- 3.1.10 The Mechanical Contractor shall supply the Owner with certified documentation from the water treatment supplier that the systems have been properly equipped, chemically cleaned and that they are maintaining sufficient levels of scale/corrosion inhibitor. The contractor shall request such documentation from the water treatment supplier within one week of presentation to the Owner.

END OF SECTION

1 General

1.1 WORK INCLUDED

- 1.1.1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.1.2 Hangers, supports, anchors, guides and restraints shall be selected to withstand all static and dynamic loading conditions which act upon the piping system and associated equipment. The Mechanical Division shall prepare detailed shop drawings showing all anchors and guides for all systems with the potential for thermal expansion/contraction and/or loads due to weight or thrust. The drawings shall bear the signed seal of a Professional Engineer licensed to practice in the appropriate discipline and place of work. The drawings shall include all details of construction, static and dynamic forces at points of attachment, etc. necessary for review and acceptance by the project Structural Owner. Make adjustments as necessary to satisfy the requirements of the Structural Division. No anchor points shall be permitted without reviewed shop drawings and, where installed prior to review, shall be removed and replaced to the satisfaction of the Owner.

2 Products

2.1 MATERIALS

- 2.1.1 Guides and anchors: United Flexible, Flexonics or Hydroflex, specifically design for the system in which they are installed.

3 Execution

3.1 INSTALLATION

- 3.1.1 Provide for the expansion and Contraction of all pipes, and install with sufficient flexibility to prevent end thrust and movements caused by thermal expansion or Contraction causing detrimental distortion or damage of connected equipment. Provide offsets between mains and equipment of sufficient length to safety absorb the expansion of the main.
- 3.1.2 Guides shall be as shown and shall be located as follows:
 - 3.1.2.1 distance from expansion loop to first guide shall be maximum 4 pipe diameters.
 - 3.1.2.2 distance from first to second guide shall be maximum 14 pipe diameters
 - 3.1.2.3 Maximum spacing between additional guides:
 - 3.1.2.3.1 3.7 m for 65 mm (12 ft. for 2-1/2 in.) pipe
 - 3.1.2.3.2 7.3 m for 75 mm and 100 mm (24 ft. for 3 in. and 4 in.) pipe 11 m for 125 mm and 150 mm (36 ft. for 5 in. and 6 in.) pipe
 - 3.1.2.3.3 14.6 m for 200 mm (48 ft. for 8 in.) pipe

3.1.2.3.4 18.3 m for 250 mm (60 ft. for 10 in.) pipe

3.1.2.3.5 22 m for 300 mm and 350 mm (72 ft. for 12 in. and 14 in.) pipe

3.1.3 Anchors shall be as shown

END OF SECTION

1 General

1.1 WORK INCLUDED

- 1.1.1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2 Products

2.1 MATERIALS

- 2.1.1 Pipe connectors, where shown, for water, shall be Hydroflex Hose, Flexonics or Vibro-Flo or corrugated metal with braided sheath.
- 2.1.2 Corrugated metal and sheath shall be of bronze or stainless steel with threaded ends for 50 mm (2 in.) pipe size and smaller and flanged ends for larger sizes.
- 2.1.3 Total length of connector shall vary from a minimum of 300 mm (12 in.) for 25 mm (1 in.) deflection, and up to 350 mm (18 in.) for 50 mm (2 in.) or greater deflection.
- 2.1.4 Minimum working pressure at 21.1 deg. C. (70 deg. F.) shall be 1200 kPa (175 psi) based on maximum working pressure not exceeding burst pressure.

3 Execution

3.1 NOT USED

END OF SECTION

1. General

1.1 WORK INCLUDED

- 1.1.1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 SUBMITTALS

1.2.1 Shop Drawings

- 1.2.1.1 Submit Shop Drawings of all catalogued components to be supplied. Include manufacturer's data sheets for certification, performance criteria, ratings, and physical dimensions and finishes.
- 1.2.1.2 Submit Shop Drawings of each supporting structural assembly required in the ductwork systems, designed by an engineer licensed to practice in the place of work in the appropriate discipline. Same design engineer stamps each and every Shop Drawing.

1.2.2 Samples: Submit samples as required.

- 1.2.2.1 Submit marked up prints showing detailed locations of all devices mounted in or on ductwork, dimensioning their locations.

2 Products

2.1 MATERIALS

- 2.1.1 Fabricate all ductwork unless specifically noted otherwise, of galvanized sheet steel with Z180 coating to A.S.T.M. A653/A653M-98.

- 2.1.2 Sealing compound: Minnesota Mining and Manufacturing or other approved manufacturer. Duct tape shall be Duro-Dyne or other approved manufacturer.

2.1.3 Flexible ducting:

- 2.1.3.1 Flexible metal ducting shall be Flexmaster Triple-Lock Aluminum Flexible ducting T/L. ULC listing S110

- 2.1.4 Access Ports shall be Lawson-Taylor or other approved manufacture of 32 mm (1-1/4 in.) dia. ports.

2.1.4.1 Flexible Connections:

- 2.1.4.2 Ventfabrics, Duro Dyne or Dyne-Air.

- 2.1.4.3 For fans less than 0.5 kPa (2 in. wg.) connections shall be minimum 680 gm/sq.m. (20 oz./sq.yd.) fire retardant polyvinyl-chloride polyester fabric equal to Vinyl-Flex.

- 2.1.4.4 For fans in excess of 0.5 kPa (2 in. wg.) connections shall be minimum 1,080 gm/sq.m. (32 oz./sq.yd.) non-toxic neoprene coated fibreglass fabric equal to Neoprene N.T.

- 2.1.4.5 For all flexible connections located outside the building (e.g. roof top units) flexible connections shall be fire retardant Hypalon coated fibreglass fabric and shall be a minimum 9915 gm/sq.m. (27 oz./sq.yd.) equal to Hypalon.

- 2.1.4.6 For all systems where the temperature may exceed 112 deg. C. (235 deg. F.) silicone rubber coated fibreglass shall be used, and shall be equal to Silicone H1-T. Submit flexible connections for review before installation.

2.1.5 Dampers:

- 2.1.5.1 Dampers: For right angle branch duct take-off from vertical riser; Air vector Vectrol or other approved manufacturer.
- 2.1.5.2 Fire Dampers: Underwriters' Laboratories labeled. Fire dampers in supply air ducts shall be rated 'Dynamic' and shall have the blades clear of the air stream. Fire dampers shall be Ruskin, Nailor Industries or Controlled Air equal to Ruskin IBD2-Style 'B' or Style 'C'. Dampers in return and exhaust systems may have the blades in the air stream if permitted by the Owner, and shall be equal to Ruskin IBD2-Style 'A'. Fire-stop flaps shall be as shown in the Underwriters' Laboratories list for the specific ceiling assembly used.
- 2.1.5.3 Combination balancing/fire damper: Price VCS4
- 2.1.5.4 Fabricate manual duct dampers as shown on Standard Details from galvanized steel
- 2.1.5.5 1.26 mm thick (0.048 in – 18 GSG gauge) or heavier. Dampers for ducts up to 300 mm (12 in.) deep shall be one blade carried on a 9 mm (3/8 in.) square steel rod mounted inside the duct. Dampers for ducts of greater depth than 300 mm (12 in.) shall be multi-blade, opposed-acting type, and shall have blades mounted in 38 mm (1-1/2 in.) steel channel frame, and interconnected for operation from one locking type hand quadrant. Dampers for right angle take-off of branch from vertical riser shall have operator extended to an accessible location. For externally insulated ducts, mount quadrant on a bracket, designed to clear the insulation. All dampers shall have indicator to show position of damperblade.
- 2.1.5.6 Fabricate splitter dampers as shown on Standard Details from at least the same thickness of galvanized steel as the duct in which it is installed, down to a minimum of
- 2.1.5.7 0.95 mm thick (0.0374 in – 20 GSG gauge). Fabricate of double thickness so that the entering edge presents a round nose to the air flow, and mount securely on hinges at the air leaving edge. Length of splitter shall be at least 1-1/2 times the width of the smaller branch duct, but in no case less than 300 mm (12 in.) long. Attach splitter hinge near the air entering edge with support passing through a clamp on the side of the duct, located where it is most accessible for external adjustment and locking of the damper.
- 2.1.5.8 Gravity backdraft dampers shall be multi-blade louvre type, constructed of light grade aluminum. Blades shall be joined with a tie bar and have rust-proof shafts rotating in bronze bushings.
- 2.1.5.9 Motorized dampers for Control Operation: In accordance with applicable requirements control systems (pneumatic) or central energy management systems section.

2.1.6 Acoustic Insulation: 25 mm (1 in.) thick rigid coated glass fibre.

- 2.1.6.1 Hardware and Accessories:
 - 2.1.6.1.1 Spin-in connections shall be specifically built for that purpose. Dampers shall be a minimum 1 gauge heavier than the ductwork in which it is installed and shall have a full length shaft pivoted at two diametrically opposed points. An indicator shall be attached to the shaft to indicate the damper position.
 - 2.1.6.1.2 Hardware for balancing or splitter dampers shall be rattle-free and leak resistant.

- 2.1.6.1.3 Bearing rods shall be sized to suit the damper size. Neoprene seals shall be used to minimize leaks. Hardware shall be Dyn-Air or equal.
- 2.1.6.1.4 Turning vanes shall be either double thickness or single thickness with extended leading and trailing edges as specified in ASHRAE and SMACNA Standards. Rails shall be securely set in the elbow so that they cannot loosen. Turning vanes shall be Dyn-Air or equal.

2.2 FABRICATION

- 2.2.1 Fabricate ductwork in accordance with applicable duct construction requirements of SMACNA.

3 Execution

3.1 INSTALLATION

- 3.1.1 Make all laps in the direction of air flow. Use no sheet metal screws in the duct where it is possible to use rivets and bolts. Hammer down all edges and slips so as to leave smooth finished surface inside the ducts.
- 3.1.2 Brace and stiffen all ducts, and make tight so that they will not breathe, rattle, vibrate or sag. Cross-break all rectangular ducts with heights or widths of 300 mm (12 in.) or larger.
- 3.1.3 Where rectangular ducts are shown, round ducts may be substituted at the Contractor's option, provided there is sufficient room. Conversion from rectangular to round duct, sizing shall be as shown on charts in ASHRAE.
- 3.1.4 Hang all ductwork securely and in a rigid manner. Provide hangers as follows:

TABLE 1: HANGERS

DUCT DIMENSION	HANGER CONSTRUCTION
Horizontal rectangular duct	
Up to 1500 mm (60 in.) for Low Pressure Ductwork Only	Two 25 mm (1 in.) x 16 US gauge straps with two screws on side of duct one screw on bottom. Hangers shall be at each joint but in no case more than a maximum 2400 mm (96 in.) on centres.
For all sizes of Medium and High Pressure Ductwork up to 3000 mm (120 in.) and Low Pressure Ductwork from 1525 mm to 3000 mm (61 in. x 120 in.)	50 mm x 50 mm x 6 mm (2 in. x 2 in. x 1/4 in.) trapeze hanger with two 9 mm (3/8 in.) dia. rods. Hangers shall be at each joint but in no case more than a maximum 2400 mm (96 in.) on centres.
3000 mm to 6000 mm (120 in. to 240 in.)	65 mm x 65 mm x 5 mm (2-1/2 in. x 2-1/2 in. x 3/16 in.) trapeze hanger with two 9 mm (3/8 in.) dia. rods. Hangers shall be at each joint but in no case more than a maximum 1200 mm (48 in.) on centres.
Horizontal round duct	
Up to 450 mm (18 in.)	One 25 mm (1 in.) x 16 US gauge hanger ring supported from one 25 mm (1 in.) x 16 US gauge hanger strap. Hanger shall be at each joint but in no case more than a maximum 2400 mm (96 in.) on centres.
475 mm to 900 mm (19 in. to 36 in.)	One 25 mm (1 in.) x 12 US gauge hanger ring supported from 25 mm (1 in.) x 12 US gauge hanger strap. Hanger shall be at each joint but in no case more than a maximum 2400 mm (96 in.) on centres.
925 mm to 1250 mm (37 in. to 50 in.)	One 25 mm (1 in.) x 12 US gauge hanger ring supported from 25 mm (1 in.) x 12 US gauge hanger strap. Hanger shall be at each joint but in no case more than a maximum 2400 mm (96 in.) on centres.
1275 mm to 2100 mm (51 in. to 84 in.)	Two 38 mm (1-1/2 in.) x 12 US gauge hanger connected to the 32 mm x 32 mm x 3 mm (1-1/4 in. x 1-1/4 in. x 1/8 in.) angle girth reinforcing of duct hanger. Hangers shall be at each joint but in no case more than a maximum 2400 mm (96 in.) on centres.

- 3.1.5 Support all vertical ducts at each floor, on all sides, with angle riveted to the ducts.
- 3.1.6 The following low pressure, medium pressure and high pressure duct construction is based on an ASHRAE method of construction, and gives a minimum standard of construction.
- 3.1.7 Alternative ASHRAE or SMACNA duct construction is acceptable, provided it meets the minimum standards as outlined by these Specifications. Submit proposed alternatives for review prior to fabrication.
- 3.1.8 Construct low pressure rectangular ducts for systems less than 0.5 kPa (2 in.) static pressure and under 10.2 m/s (2000 fpm) velocity as follows:

TABLE 2: LOW PRESSURE DUCT CONSTRUCTION

MAX. DUCT DIMENSION	SHEET METAL US GAUGE	TRANSVERSE JOINT CONNECTION AND BRACING
Up to 300 mm (12 in.)	26	Flat drive or flat 'S' no bracing
325 mm to 425 mm (13 in. to 18 in.)	24	Flat drive or flat 'S' no bracing
475 mm to 750 mm (19 in. to 30 in.)	24	25 mm (1 in.) standing 'T' bracing 25 mm x 25 mm x 3 mm (1 in. x 1 in. x 1/8 in.) at maximum 1500 mm (60 in.) centres.
775 mm to 1050 mm (31 in. to 42 in.)	22	25 mm (1 in.) standing 'T' bracing 25 mm x 25 mm x 3 mm (1 in. x 1 in. x 1/8 in.) at maximum 1500 mm (60 in.) centres.
1075 mm to 1200 mm (43 in. to 48 in.)	22	38 mm (1-1/2 in.) standing 'T'; bracing 38 mm x 38 mm x 3 mm (1-1/2 in. x 1-1/2 in. x 1/8 in.) at maximum 1500 mm (60 in.) centres.
1225 mm to 1350 mm (49 in. to 54 in.)	22	38 mm (1-1/2 in.) standing 'T'; bracing 38 mm x 38 mm x 3 mm (1-1/2 in. x 1-1/2 in. x 1/8 in.) at maximum 1200 mm (48 in.) centres.
1375 mm to 1500 mm (55 in. to 60 in.)	20	38 mm (1-1/2 in.) standing 'T'; bracing 38 mm x 38 mm x 3 mm (1-1/2 in. x 1-1/2 in. x 1/8 in.) at maximum 1200 mm (48 in.) centres.
1525 mm to 2100 mm (61 in. to 84 in.)	20	38 mm (1-1/2 in.) standing 'T'; bracing 38 mm x 38 mm x 3 mm (1-1/2 in. x 1-1/2 in. x 1/8 in.) at maximum 1200 mm (48 in.) centres.
2125 mm to 2400 mm (85 in. to 96 in.)	18	50 mm (2 in.) standing 'T' bracing 38 mm x 38 mm x 5 mm (1-1/2 in. x 1-1/2 in. x 3/16 in.) at maximum 600 mm (24 in.) centres.
2425 mm to 3000 mm (97 in. to 120 in.)	18	50 mm (2 in.) standing 'T' bracing 50 mm x 50 mm x 6 mm (2 in. x 2 in. x 1/4 in.) at maximum 600 mm (24 in.) centres.
3025 mm and over (121 in. and over)	18	As above with addition of tie rods at 300 mm (120 in.) centres for joint bracing.

- 3.2.1 Bracing spacing shown is maximum spacing between two bracings or between bracing and joint.
- 3.2.2 Locate bracings mid-way between joints.
- 3.2.3 Make longitudinal joints Pittsburgh lock seam at edge of duct, and grooved seam on face of duct.
- 3.2.4 Construct medium pressure rectangular ducts as follows:

TABLE 3: MEDIUM PRESSURE RECTANGULAR DUCT CONSTRUCTION

MAX. DUCT DIMENSION	SHEET METAL US GAUGE	TRANSVERSE JOINT CONNECTION & BRACING
Up to 300 mm (12 in.)	24	25 mm (1 in.) standing seam, 16 mm (5/8 in.) welded flange 25 mm (1 in.) pocket lock, no bracing.
325 mm to 425 mm (13 in. to 18 in.)	24	25 mm (1 in.) standing seam, 22 mm (7/8 in.) welded flange, 25 mm (1 in.) pocket lock, bracing 25 mm x 25 mm x 16 gauge (1 in. x 1 in. x 16 UG gauge) at 1200 mm (48 in.) centres.
475 mm to 600 mm (19 in. to 24 in.)	22	32 mm (1-1/4 in.) standing seam, 35 mm (1-3/8 in.) welded flange, 30 mm (1-1/8 in.) pocket lock, bracing 25 mm x 25 mm x 3 mm (1 in. x 1 in. x 1/8 in.) at maximum 120 mm (48 in.) centres.
625 mm to 900 mm (25 in. to 36 in.)	22	38 mm (1-1/2 in.) standing seam, 38 mm (1/2 in.) pocket lock, bracing 25 mm x 25 mm x 3 mm (1 in. x 1 in. x 1/8 in.) at maximum 120 mm (48 in.) centres.
925 mm to 1200 mm (37 in. to 48 in.)	22	50 mm (2 in.) standing seam or 50 mm (2 in.) flanged joint, bracing 38 mm x 38 mm x 3 mm (1-1/2 in. x 1-1/2 in. x 1/8 in.) at maximum 750 mm (30 in.) centres.
1125 mm to 1500 mm (49 in. to 60 in.)	20	38 mm (1-1/2 in.) standing seam or 38 mm (1-1/2 in.) flanged joint with tie rod in centre, bracing 50 mm x 50 mm x 3 mm (2 in. x 2 in. x 1/8 in.) at maximum 600 mm (24 in.) centres.
1525 mm to 1800 mm (61 in. to 72 in.)	20	38 mm (1-1/2 in.) standing seam or 38 mm (1-1/2 in.) flanged joint with tie rod in centre, bracing 50 mm x 50 mm x 3 mm (2 in. x 2 in. x 1/8 in.) at maximum 600 mm (24 in.) centres.
1825 mm to 2100 mm (73 in. to 84 in.)	18	50 mm (2 in.) standing seam or 38 mm (1-1/2 in.) flanged joint with tie rod in centre, bracing 65 mm x 65 mm x 5 mm (2-1/2 in. x 2-1/2 in. x 3/16 in.) at maximum 600 mm (24 in.) centres.
2425 mm and over (96 in. and over)	18	50 mm (2 in.) standing seam or 38 mm (1-1/2 in.) flanged joint with tie rod in centre, bracing 65 mm x 65 mm x 5 mm (2-1/2 in. x 2-1/2 in. x 3/16 in.) at maximum 600 mm (24 in.) centres.

- 3.3.1 Bracing spacing shown above is maximum spacing between two bracings or between bracing and joint. Locate bracing mid-way between joints.
- 3.3.2 Make longitudinal joints Pittsburgh lock seam at edge of duct, and grooved seam on face of duct.
- 3.3.3 Seal all joint of all ducts. Brush joints with the compound before and again after assembly.
- 3.3.4 Seal the bottom and side joints of outside air ducts or plenums water-tight.
- 3.3.5 Flexible hose shall be connected to sheet metal duct and diffusers using duct sealer, minimum of two screws separated by 180 degrees and metal draw bands. Duct tape is not acceptable.
- 3.3.6 Flexible ductwork may be used under the following conditions:
 - 3.3.6.1 Flexible ductwork shall be used where shown to allow easy location of diffusers.
 - 3.3.6.2 Minimum length of flexible duct used to connect diffusers and interior troffers shall be 2,400 mm (84 inches).
 - 3.3.6.3 Maximum length of flexible duct shall be 3,000 mm (120 inches).
 - 3.3.6.4 Flexible ductwork shall not pass through floors or fire walls,
 - 3.3.6.5 Flexible ductwork shall be a single section of duct (no joints). In the event that building construction requires connection between lengths of flexible duct use a rigid section of duct as the joint. Flexible duct shall be secure to the rigid section using ties and sealant.
 - 3.3.6.6 Flexible duct lengths greater than 2,400 mm (84 inches) shall be supported at the midpoint with strap hangers.
- 3.3.7 Where ductwork passes through a wall or floor, other than when a fire damper is required, pack around the duct using a fire resistant material to ensure a sound and airtight joint.
- 3.3.8 If changes of size of ducts are necessary because of building construction, maintain the same circular equivalent for the new size. Ratio of the longest side of the duct to the least shall not exceed 4 to 1 unless specifically authorized by the Owner.
- 3.3.9 Select the gauge of metal and method of construction for the new size. Notify the Owner of any change before such changes are incorporated into the work.
- 3.3.10 If changes of location of duct, are required because of building construction, review with the Owner before the locations indicated are changed in any way.
- 3.3.11 Make changes of direction of horizontal ducts with elbows having an inside radius not less than 3/4 the width of the duct. Make change of direction from horizontal to vertical duct with elbows having an inside radius equal to the depth of the duct. Where this is not possible due to the building construction, use turning vanes.
- 3.3.12 Provide access ports at convenient locations in all main ducts and main branch take-offs with airtight covers and extension sleeves through insulation to allow air meter readings. Access ports shall be approved by the Owner and the testing company before installation.

- 3.3.13 Provide flexible connections at each air handling unit and fan duct connection.
- 3.3.14 Install manual duct dampers as shown on Standard Details. Ensure dampers for right angle take-off of branch from vertical riser have operator extended to an accessible location. Adjust quadrants to clear duct insulation.
- 3.3.15 Provide splitter dampers as shown on Standard Details.
- 3.3.16 Incorporate gravity backdraft dampers where shown.
- 3.3.17 Install motorized dampers where directed.
- 3.3.18 Install fire dampers where shown and at all penetrations through all fire rated assemblies. Where fire dampers are shown in grilles or diffusers at ceiling level they shall be firestop flap. Obtain local authorities approvals for all damper locations and keep one set of marked-up prints on site. Approvals shall be obtained before installation of fire dampers.
- 3.3.19 Receive automatic dampers from separate Section on site, and set in place under the supervision of the control manufacturer.
- 3.3.20 Provide access panels at all fire dampers, gravity dampers, motorized dampers, coils, heaters, fan bearings or similar equipment requiring occasional maintenance or inspection. Panels shall be 600 mm x 450 mm (24 in. x 18 in.) or full width of duct if less than 450 mm (18 in.) wide. Panels shall be of double wall construction and shall be internally insulated on insulated ducts. Frame shall be of structural angle with welded corners, gasketed to receive the panel. Panel shall be held in place with 4 window sash locks.
- 3.3.21 Paint visible internal surface behind each grille or register flat black.
- 3.3.22 Where duct is acoustically lined, duct dimensions shown are net, inside of lining.
- 3.3.23 Apply acoustic insulation internally to ductwork where shown. In addition, internally line all low or medium pressure supply air ductwork in mechanical rooms, fan rooms, or equipment rooms. For acoustic lining downstream of VAV boxes refer to Section 23 36 16.00 – VARIABLE VOLUME BOXES. Install using both pins and adhesive. Pins shall be maximum 450 mm (18 in.) centres and shall be tack welded to the duct or plenum. Seal all edges of acoustic insulation to prevent air erosion with sheet metal nosing that overlaps the insulation by 19 mm (3/4 in.) minimum.
- 3.3.24 Spin-in connections shall only be used downstream of variable volume boxes.
- 3.3.25 Ductwork shall be run parallel to the closest wall. Coordinate with piping and structural elements.

- 3.3.26 All open ends of ductwork that do not have a diffuser, grille or register shall have a protective screen mounted in a suitable frame to connect the screen securely to the duct, wall and floor as applicable. Where a duct terminates at a supply, return or exhaust air opening provided by other sections and located less than 2000mm (79 in.) Above the finished floor, the screen shall be installed and painted matte black and shall not be capable of passage of anything larger than a 15mm (1/2 in.) Sphere through the openings.
- 3.3.27 Supply air ductwork to variable volume boxes shall be rigid duct of size shown in schedules. If the length exceeds 3000 mm (10 ft.) or if there are 2-45 deg. elbows or 1-90 deg. elbow or more increase in supply air ductwork to the variable volume box one size. If the length exceeds 6000 mm (20 ft.) increase the duct by two sizes. Under no conditions shall be supply ductwork exceed 9000 mm (30 ft.) or have more than 3-90 deg. elbows or the equivalent.

END OF SECTION

1 General

1.1 WORK INCLUDED

1.1.1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.1.2 Casings and plenums for built-up air handling units shall be either prefabricated high noise attenuation and high sound transmission loss panels as specified under Section 21 05 48.00 – VIBRATION AND NOISE CONTROLS, or field built-up panels as shown.

1.1.3 Field built-up panels shall be as specified below.

1.2 RELATED WORK SPECIFIED ELSEWHERE

1.2.1 120V/1/60 power wiring to the junction box – under Electrical Division.

1.3 SUBMITTALS

1.3.1 Shop Drawings – Submit Shop Drawings for casing, plenum, coil supports and filter supports for review.

2 Products

2.1 MATERIALS

2.1.1 Field built-up panels shall be 1.56 mm thick (0.614 in – 16 GSG gauge) galvanized steel sheets with coating to A.S.T.M. A653/A653M-98, Designation Z275. Construction of plenums shall be as shown. Casings, plenums and connections between components of built-up apparatus shall be constructed from a completely self-supporting rigid structural steel frame bolted or welded. The entire casing shall be constructed to absolutely prevent deflection or drumming under vacuum or pressure conditions applicable to the particular system, with all joints caulked or gasketed to give an airtight applicable to the particular system, with all joint caulked or gasketed to give an airtight installation. Waterproof gaskets shall be provided at all wet sections. At the floor line and at other joints where casing joins masonry construction, panels shall be attached to a galvanized steel angle which has been secured to masonry with expansion shields and bolts on approximately 300 mm (12 in.) centres and caulked air and water tight to masonry. At floor, provide channel to which insulation can be finished off.

2.1.2 Provide air tight hinged access doors where shown and install to swing open against the plenum pressure. Doors shall be 38 mm (1-1/2 in.) minimum thickness, with each face formed of 20 US gauge galvanized steel. Latches shall be factory made specifically for this application and shall be operable from either side. Reinforce frame for door opening with 45 mm x 32 mm x 3 mm (1-3/4 in. x 1-1/4 in. x 1/8 in.) steel angle, welded at the corners.

- 2.1.3 Gasket against which door closes shall be foamed rubber or plastic. Doors shall be 500 mm wide x 1350 mm high (20 in. x 54 in.) located 450 mm (18 in.) clear of floor unless shown otherwise. Each door shall have a 300 mm x 300 mm (12 in. x 12 in.) inspection window with 6 mm (1/4 in.) thick safety glass.
- 2.1.4 Provide drain pans under each cooling coil as specified in Section 23 82 16.00 – COILS.
- 2.1.5 Provide hot rolled steel or H.S.S. steel framework to support the coils and drain pans. In cooling coil sections the lowest portion of the support frame and any other section that may be in contact with water shall be Type 316 stainless steel.
- 2.1.6 Provide adjustable rigid sheet metal baffles, where shown or required in all supply air mixing plenums to prevent stratification of entering air.
- 2.1.7 Provide all catwalks in apparatus casings for servicing of filters.
- 2.1.8 Provide separately switched marine lights with protective metal cages and glass seals installed on the wall opposite access doors. Extend wiring to lights and switches from a junction box (one per unit).

3 Execution

3.1 INSTALLATION

- 3.1.1 Provide readily removable sections of plenums for removal of coils, fan wheels, and motors. These sections shall be flanged, gasketed and bolted such that the section may be removed after withdrawing the bolts.
- 3.1.2 Caulk all other joints in plenums. Fit pipe penetrating plenum with a 2.71 mm thick (0.1067 in – 12 GSG gauge) flange, welded to the pipe and bolted and caulked to the plenum.
- 3.1.3 Framework for support of coils shall be such that any coil may be removed without disturbing remaining coils.
- 3.1.4 Anti-stratification baffles in mixing plenums shall be adjusted after start-up of system and before balancing when outside conditions permit a representative test with thermocouple traverse and to give mixing conditions satisfactory to the Owner. The baffles shall then be securely fixed in position.

END OF SECTION

1 General

1.1 WORK INCLUDED

1.1.1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.1.2 This section is intended for all outside air intake and exhaust plenums. Refer to Section 21 05

1.1.3 48.00 – VIBRATION AND NOISE CONTROL for acoustic plenums.

1.2 SUBMITTALS

1.2.1 Shop Drawings – Submit shop drawings of the plenums for review. Shop drawings shall include material type and construction details.

2 Products

2.1 MATERIALS – FIELD BUILT-UP PLENUMS

2.1.1 Field built-up panels shall be 1.56 mm thick (0.614 in – 16 GSG gauge) galvanized steel sheets with coating to A.S.T.M. A653/A653M-98, Designation Z275. Construction of plenums shall be as shown. Casings, plenums and connections between components of built-up apparatus shall be constructed from a completely self-supporting rigid structural steel frame bolted or welded. The entire casing shall be constructed to absolutely prevent deflection or drumming under vacuum or pressure conditions applicable to the particular system, with all joints caulked or gasketed to give an airtight applicable to the particular system, with all joint caulked or gasketed to give an airtight installation. Waterproof gaskets shall be provided at all wet sections. At the floor line and at other joints where casing joins masonry construction, panels shall be attached to a galvanized steel angle which has been secured to masonry with expansion shields and bolts on approximately 300 mm (12 in.) centres and caulked air and water tight to masonry. At floor, provide channel to which insulation can be finished off.

2.1.2 The inner wall of the floor shall be fabricated from minimum 0.9525 mm thick (0.0375 in – 20 USS gauge) or 1.27 mm thick (0.05 in – 18 USG gauge) galvanized steel sheet and formed stainless steel angles, and shall extend full length of plenum, double sloped to prevent standing water. The inner skin shall be welded construction. Provide 3 in. (75mm) of insulation between the floor panels.

2.1.3 Provide insulation on field built-up plenums in conformance with Section 21 07 00.00 – MECHANICAL INSULATION

- 2.1.4 Construction of plenums shall be as shown and shall be constructed from a completely self-supporting rigid structural steel frame bolted or welded. The entire plenum shall be constructed to absolutely prevent deflection or drumming under vacuum or pressure conditions applicable to the particular system, with all joints caulked or gasketed to give an airtight installation.
- 2.1.5 Waterproof gaskets shall be provided at all wet sections. At the floor line, and at other joints where casing joins masonry construction, panels shall be attached to a galvanized steel angle that has been secured to masonry with expansion shields and bolts on approximately 12 in. (300 mm) centres and caulked air and water tight to masonry. At floor, provide channel to which insulation can be finished off.
- 2.1.6 Doors shall be flush mounted, minimum 1350 mm x 500 mm (54 in. x 20 in.) size and mounted 450 mm (18 in.) above the floor and shall be constructed of materials similar to the plenum panels. Doors shall have matching 2.7533 mm thick (12 G.S. gauge) frames, heavy duty hinges, pressure type latches operable from inside and outside and continuous rubber seal gaskets. Doors shall open against the plenum pressure.

3 Execution

3.1 INSTALLATION

- 3.1.1 Make all connections in a way to ensure the integrity of the plenum. Provide flanged or collar openings for ducts constructed of 1.6129 mm (1/16 in.) thick (16 G.S. gauge) galvanized steel. Fit pipes penetrating plenum with a 0.1067" - 12 GSG gauge (2.71 mm thick) flange, welded to the pipe and bolted and caulked to the plenum. Caulk all other joints in plenums
- 3.1.2 Where panels are required inside plenums, they shall be similar to the wall panels to prevent air crossover. Internal panels are not required to be double wall.
- 3.1.3 Provide a 200mm thick curb for all full height plenums. Install a plenum drain at the bottom of plenum where shown on the drawings with a minimum of one drain per plenum. Provide a cast iron dome if there is a chance of debris entering the plenum. Double slope the plenum floor to the drain.
- 3.1.4 Coat all plenum seams and welds with 2 coats of rust resistant finish.
- 3.1.5 Provide readily removable sections of plenums. These sections shall be flanged, gasketed and bolted such that the section may be removed after withdrawing the bolts.
- 3.1.6 Each plenum shall be flood tested to ensure no leaks are present. Plug the drain in the plenum and fill the plenum with 3 inches of water using a garden hose and wait for 5 minutes. Visually inspect for leaks and perform remedial work as required. Notify Owner, Testing and Balancing trades, and/or Owner to witness the flood test.

END OF SECTION

1 GENERAL

1.1 RELATED REQUIREMENTS

1.1.1 Section 23 01 10 - Mechanical General Provisions.

1.1.2 Section 23 01 20 - Mechanical Submittals.

1.2 REFERENCES

1.2.1 CSA B228.1- Pipes, Ducts and Fittings for Residential Type Air Conditioning.

1.3 PRODUCT DATA

1.3.1 Submit product data in accordance with Section 23 01 20 - Mechanical Submittals.

1.3.2 Indicate the following:

1.3.2.1 Flexible connections.

1.3.2.2 Duct access doors.

1.3.2.3 Turning vanes.

1.3.2.4 Instrument test ports.

1.4 CERTIFICATION OF RATINGS

1.4.1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

2.1.1 Flexible Connections: To meet Specifications.

2.1.2 Instrument Test Ports: Duro Dyne.

2.1.3 Water Heating Coils: Heatcraft, Engineered Air, Trane, Aerofin.

2.2 GENERAL

2.2.1 Manufacture in accordance with CSA B228.1.

2.3 FLEXIBLE CONNECTIONS

2.3.1 Frame: galvanized sheet metal frame thick with fabric clenched by means of double locked seams.

2.3.2 Material:

2.3.2.1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40EC to plus 90EC, density of 1.3 kg/sq.m.

2.4 ACCESS DOORS IN DUCTS

2.4.1 Non-insulated ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.

2.4.2 Insulated ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.

2.4.3 Gaskets: neoprene or foam rubber.

2.4.4 Hardware:

2.4.4.1 Up to 300 x 300 mm: 2 sash locks.

2.4.4.2 301 to 450 mm: 4 sash locks.

2.4.4.3 451 to 1000 mm: piano hinge and minimum 2 sash locks.

2.4.4.4 Doors over 1000 mm: piano hinge and 2 handles operable from both sides.

2.4.4.5 Hold open devices.

2.5 TURNING VANES

2.5.1 Factory or shop fabricated single thickness and double thickness with without trailing edge, to recommendations of SMACNA and as indicated.

2.6 INSTRUMENT TEST PORTS

2.6.1 1.6 mm thick steel zinc plated after manufacture.

2.6.2 Cam lock handles with neoprene expansion plug and handle chain.

2.6.3 28 mm minimum inside diameter. Length to suit insulation thickness.

2.6.4 Neoprene mounting gasket.

2.6.5 Acceptable material: Duro Dyne IP1 or IP2.

3 EXECUTION

3.1 INSTALLATION

3.1.1 Flexible connections:

3.1.1.1 Install in following locations:

- 3.1.1.1.1 Inlets and outlets to supply air units and fans.
- 3.1.1.1.2 Inlets and outlets of exhaust and return air fans.
- 3.1.1.1.3 As indicated.

3.1.1.2 Length of connection: 100 mm.

3.1.1.3 Minimum distance between metal parts when system in operation: 75 mm.

3.1.1.4 Install in accordance with recommendations of SMACNA.

3.1.1.5 When fan is running:

- 3.1.1.5.1 Ducting on each side of flexible connection to be in alignment.
- 3.1.1.5.2 Ensure slack material in flexible connection.

3.1.2 Access doors:

3.1.2.1 Size:

- 3.1.2.1.1 1200 x 900 mm for person size entry.
- 3.1.2.1.2 300 x 300 mm for servicing entry.
- 3.1.2.1.3 150 x 150 mm for viewing.
- 3.1.2.1.4 As indicated.

3.1.2.2 Location:

- 3.1.2.2.1 At fire dampers.
- 3.1.2.2.2 At control dampers.
- 3.1.2.2.3 At devices requiring maintenance.
- 3.1.2.2.4 At locations required by code.
- 3.1.2.2.5 At reheat coils.
- 3.1.2.2.6 Elsewhere as indicated.

3.1.3 Instrument test ports.

3.1.3.1 General:

- 3.1.3.1.1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.

3.1.3.2 Locations.

3.1.3.2.1 For traverse readings:

- At ducted inlets to roof and wall exhausters.
- At inlets and outlets of other fan systems.
- At main and sub-main ducts.
- And as indicated.

3.1.3.2.2 For temperature readings:

- At outside air intakes.
- In mixed air applications in locations as approved by Owner.
- At inlet and outlet of coils.
- Downstream of junctions of two converging air streams of different temperatures.
- And as indicated.

3.1.4 Turning vanes:

3.1.4.1 Install in accordance with recommendations of SMACNA and as indicated.

END OF SECTION

1 GENERAL

1.1 RELATED REQUIREMENTS

1.1.1 Section 23 01 10 - Mechanical General Requirements.

1.1.2 Section 23 01 20 - Mechanical Submittals.

1.2 REFERENCES

1.2.1 SMACNA HVAC D20 -Duct Construction Standards, Metal and Flexible-1985.

1.3 PRODUCT DATA

1.3.1 Submit product data in accordance with Section 23 01 20 - Mechanical Submittals.

2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

2.1.1 Dampers: Honeywell, Johnsons, Landis & Gyr, Tamco Canada, Westvent.

2.2 GENERAL

2.2.1 Manufacture to SMACNA standards.

2.3 SINGLE BLADE DAMPERS

2.3.1 Of same material as duct, but one sheet metal thickness heavier. V-groove stiffened.

2.3.2 Size and configuration to recommendations of SMACNA, except maximum height 100 mm as indicated.

2.3.3 Locking quadrant with shaft extension to accommodate insulation thickness.

2.3.4 Inside and outside nylon end bearings.

2.3.5 Channel frame of same material as adjacent duct, complete with angle stop.

2.4 MULTI-BLADED DAMPERS

2.4.1 Factory manufactured of material compatible with duct.

2.4.2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.

2.4.3 Maximum blade height: 100 mm as indicated.

2.4.4 Bearings: self-lubricating nylon.

2.4.5 Linkage: shaft extension with locking quadrant.

2.4.6 Channel frame of same material as adjacent duct, complete with angle stop.

3 EXECUTION

3.1 INSTALLATION

- 3.1.1 Install where indicated.
- 3.1.2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- 3.1.3 For supply, return and exhaust systems, balancing dampers are to be located in each branch duct.
- 3.1.4 Each grille, register and diffuser connection to have balancing damper located as close as possible to main ducts.
- 3.1.5 Install splitter damper blade, pivot and control rod in rigid manner to prevent vibration.

END OF SECTION

1 GENERAL

1.1 RELATED REQUIREMENTS

1.1.1 Section 23 01 10 - Mechanical General Requirements.

1.1.2 Section 23 01 20 Mechanical Submittals.

1.1.3 Section 25 01 10 - HVAC Controls General Provisions.

1.1.4 Electrical.

1.2 REFERENCES

1.2.1 ASTM A525M-87, Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.

1.3 PRODUCT DATA

1.3.1 Submit product data in accordance with Section 23 01 20 - Mechanical Submittals.

1.3.2 Indicate the following:

1.3.2.1 Performance data.

1.4 MAINTENANCE DATA

1.4.1 Provide maintenance data for incorporation into manual specified in Section 23 01 20 - Mechanical Submittals.

1.5 CERTIFICATION OF RATINGS

1.5.1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency.

2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

2.1.1 Dampers: Honeywell, Johnson, Landis & Gyr, Moore, Tamco Canada, Westvent.

2.2 MULTI-LEAF

2.2.1 Opposed blade type as indicated.

2.2.2 Structurally formed steel or Extruded aluminum, interlocking blades, complete with extruded vinyl seals, spring stainless steel side seals, structurally formed and welded galvanized steel or extruded aluminum frame.

2.2.3 Pressure fit self-lubricated bronze bearings.

- 2.2.4 Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.
- 2.2.5 Operator: to Division 25.
- 2.2.6 Performance: leakage in closed position to be less than 2% of rated air flow.
- 2.2.7 Acceptable material: Tamco.

3 EXECUTION

3.1 INSTALLATION

- 3.1.1 Install where indicated.
- 3.1.2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.
- 3.1.3 Seal multiple damper modules with silicon sealant.
- 3.1.4 Upon system start-up, ensure that dampers operate properly.

END OF SECTION

1 GENERAL

1.1 RELATED REQUIREMENTS

- 1.1.1 Section 23 01 10 - Mechanical General Provisions.
- 1.1.2 Section 23 01 20 - Mechanical Submittals.
- 1.1.3 Division 25 - Controls.
- 1.1.4 Electrical.

1.2 REFERENCES

- 1.2.1 ANSI/NFPA 90A-1985, Installation of Air Conditioning and Ventilating Systems.
- 1.2.2 CAN4-S112-M82(R1987), Fire Test of Fire Damper Assemblies.
- 1.2.3 CAN4-S112.2-M84, Fire Test of Ceiling Firestop Flap Assemblies.
- 1.2.4 ULC-S505-1974, Fusible Links for Fire Protection Service.

1.3 PRODUCT DATA

- 1.3.1 Submit product data in accordance with Section 23 01 20 - Mechanical Submittals.
- 1.3.2 Indicate the following:
 - 1.3.2.1 Fire dampers.
 - 1.3.2.2 Fire stop flaps.

1.4 MAINTENANCE DATA

- 1.4.1 Provide maintenance data for incorporation into manual specified in Section 23 01 20 - Mechanical Submittals.

1.5 MAINTENANCE MATERIALS

- 1.5.1 Provide maintenance materials in accordance with Section 23 01 10 - Spare Parts.
- 1.5.2 Provide following:
 - 1.5.2.1 6 fusible links of each type.

1.6 CERTIFICATION OF RATINGS

- 1.6.1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- 2.1.1 Dampers: Canada Advanced Air Ltd., Controlled Air Manufacturing, Nailor Hart, Penn Ventilator Canada Ltd., Ruskin(Kerr- Hunt.

2.2 FIRE DAMPERS

- 2.2.1 Fire dampers: listed and bear label of ULC, meet requirements of provincial fire authority and NFPA 90A and authorities having jurisdiction.
- 2.2.2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
- 2.2.3 Top hinged: offset single damper, round or square; multi-blade hinged or interlocking type; sized to maintain full duct cross section as indicated.
- 2.2.4 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.
- 2.2.5 40 x 40 x 3 mm retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.
- 2.2.6 Acceptable material: Nailor Hart.

2.3 FIRE STOP FLAPS

- 2.3.1 To be ULC listed and labelled.
- 2.3.2 Construct of minimum 1.5 mm thick sheet steel with 1.6 mm thick non-asbestos ULC listed insulation and corrosion-resistant pins and hinges.
- 2.3.3 Flaps to be held open with fusible link conforming to ULC-S505 and close at 74 EC or as indicated.

3 EXECUTION

3.1 INSTALLATION

- 3.1.1 Install in accordance with NFPA 90A and in accordance with conditions of ULC listing.
- 3.1.2 Fire damper assemblies to be fire tested in accordance with CAN4-S112.
- 3.1.3 Fire stop flap assemblies to be fire tested in accordance with CAN4-S112.2.
- 3.1.4 Maintain integrity of fire separation.
- 3.1.5 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.

- 3.1.6 Install access door adjacent to each damper. See Section 23 33 00 - Duct Accessories.
- 3.1.7 Coordinate with installer of firestopping.

END OF SECTION

1 GENERAL

1.1 RELATED REQUIREMENTS

- 1.1.1 Section 23 01 10 - Mechanical General Requirements.
- 1.1.2 Section 23 01 20 - Mechanical Submittals.
- 1.1.3 Section 23 31 13 - Ductwork - Low Pressure - Metallic to 500 Pa.
- 1.1.4 Section 15892: Ductwork - High Pressure - Metallic to 2500 pa.

1.2 REFERENCES

- 1.2.1 SMACNA HVAC Duct Construction Standards, Metal and Flexible-1985.
- 1.2.2 ASTM C177-85, Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
- 1.2.3 CAN/ULC-S102-M88, Surface Burning Characteristics of Building Materials and Assemblies.
- 1.2.4 CGSB 51-GP-10M-76, Thermal Insulation, Mineral Fibre, Block or Board, for Ducting, Machinery and Boilers.
- 1.2.5 CGSB 51-GP-11M-76, Thermal Insulation, Mineral Fibre, Blanket, for Piping, Ducting, Machinery and Boilers.
- 1.2.6 ANSI/NFPA 90A-1985, Installation of Air Conditioning and Ventilating Systems.
- 1.2.7 ANSI/NFPA 90B-1984, Installation of Warm Air Heating and Air Conditioning Systems.

1.3 PRODUCT DATA

- 1.3.1 Submit product data in accordance with Section 23 01 20 - Mechanical Submittals.

2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- 2.1.1 Duct Liner: Fibreglas, Manson, Manville, Knauf. Sealants and Tape: Duro
- 2.1.2 Sealants and Tapes: Duro Dyne, Foster.

2.2 DUCT LINER

- 2.2.1 General:
 - 2.2.1.1 Fibrous glass duct liner: air stream side faced with mat facing.

- 2.2.1.2 Flame spread rating shall not exceed 25. Smoke development ratings shall not exceed 50 when tested in accordance with CAN/ULC-S102.
- 2.2.2 Rigid:
 - 2.2.2.1 Use on flat surfaces where indicated.
 - 2.2.2.2 25 mm thick, to CGSB 51-GP-10M, fibrous glass rigid board duct liner.
 - 2.2.2.3 Density: 36 kg/m³; minimum.
 - 2.2.2.4 Thermal resistance to be minimum 0.76 m². °C/W for 25 mm thickness.
- 2.2.3 Flexible:
 - 2.2.3.1 Use on round or oval surfaces where indicated.
 - 2.2.3.2 25 mm thick, to CGSB-51-GP-11M, fibrous glass blanket duct liner.
 - 2.2.3.3 Density: 24 kg/m³ minimum.
 - 2.2.3.4 Thermal resistance to be minimum 0.74 m². °C/W for 25 mm thickness when tested in accordance with ASTM C177, at 24 °C mean temperature.
- 2.2.4 Acceptable Material: Fibreglas.
- 2.3 ADHESIVE
 - 2.3.1 Meet requirements of ANSI/NFPA 90A and ANSI/NFPA 90B.
 - 2.3.2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 29 °C to plus 93 °C.
 - 2.3.3 Acceptable material: Duro Dyne 1A-22.
- 2.4 FASTENERS
 - 2.4.1 Weld pins 2.0 mm diameter, length to suit thickness of insulation. Metal retaining clips, 32 mm square.
 - 2.4.2 Acceptable material: Duro Dyne PN series with Nc or Pc-1 series clips.
- 2.5 JOINT TAPE
 - 2.5.1 Poly-Vinyl treated open weave fiberglass membrane 50 mm wide.
 - 2.5.2 Acceptable material: Duro-Dyne FT2.
- 2.6 SEALER
 - 2.6.1 Meet requirements of ANSI/NFPA 90A and ANSI/NFPA 90B.
 - 2.6.2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 68°C to plus 93°C.
 - 2.6.3 Acceptable material: Duro Dyne S-2.

3 EXECUTION

3.1 GENERAL

- 3.1.1 Do work in accordance with recommendations of SMACNA duct liner standards as indicated in SMACNA HVAC Duct Construction Standards, Metal and Flexible, except as specified otherwise.
- 3.1.2 Line inside of ducts where indicated.
- 3.1.3 Duct dimensions, as indicated, are clear inside duct lining.

3.2 DUCT LINER

- 3.2.1 Install in accordance with manufacturer's recommendations, and as follows:
 - 3.2.1.1 Fasten to interior sheet metal surface with 100% coverage of adhesive.
 - 3.2.1.2 In addition to adhesive, install weld pins not less than 2 rows per surface and not more than 425 mm on centres.

3.3 JOINTS FOR LOW PRESSURE DUCTS TO SECTION 23 31 13

- 3.3.1 Protect leading and trailing edges of each Duct section with approved sealer to SMACNA standards.
- 3.3.2 Seal all joints with approved sealer to SMACNA standards.
- 3.3.3 Seal all exposed edges and all damaged areas of liner with Joint Tape and Sealer.
- 3.3.4 Replace badly damaged area of Liner at the discretion of the Owner.

END OF SECTION

1 General

1.1 WORK INCLUDED

- 1.1.1 Conform to Section 21 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- 1.2.1 Electrical hard wire supply and primary connections to electrical components – under Electrical Division.

1.3 SUBMITTALS

1.3.1 Shop Drawings:

- 1.3.1.1 .1 Submit Shop Drawings of all fans with catalogued components to be supplied. Include manufacturer's data sheets for, performance criteria, ratings, and physical dimensions and finishes. Provide fan curves for each fan at the specified operation point, with the flow, static pressure and horsepower clearly plotted. Provide outlet velocity and both inlet and outlet sound power readings for the eight octave bands.

1.3.2 Manufacturer's Data

- 1.3.2.1 Conform to AMCA standard 205, 211 and 311. Fans shall be tested in accordance with ANSI/AMCA Standard 210 and AMCA Standard 300 in an AMCA accredited laboratory and shall be certified to bear the AMCA seal for air and sound performance.
- 1.3.2.2 Classification for Spark Resistant Construction Conform to AMCA 99.
- 1.3.2.3 Each fan shall be given an electronic vibration analysis in accordance with ANSI/AMCA Standard 204, while operating at the specified fan RPM. The vibration signatures shall be taken on each bearing in the horizontal, vertical and axial direction. The maximum allowable fan vibration shall be 3.81 mm/sec (0.15 in/sec) peak velocity, filter-in as measured at the fan RPM. Provide report summarizing test results for inclusion in operations and maintenance manuals.

2 Products

2.1 MATERIALS

- 2.1.1 Except as otherwise indicated, all centrifugal and utility fans shall be Carnes, Cook, FlaktWoods, Greenheck, PennBarry or Twin City.
- 2.1.2 All fans shall comply with UL/cUL 705.
- 2.1.3 All fans used to convey grease laden air shall comply with UL/cUL 762, meet NFPA 96A and have a grease collection device.

- 2.1.4 All fans used for smoke control shall be UL/cUL listed and tested for operation at 260 Deg. C. (500 Deg. F.) for a minimum of four hours, and 520 Deg. C. (1000 Deg. F.) for a minimum of fifteen minutes.
 - 2.1.5 The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The scroll wrapper and side panels shall be steel. The entire fan housing shall have continuously welded seams for leak-proof operation. Bearing support shall be constructed of welded steel members.
 - 2.1.6 All steel fan components shall be coated with an electrostatically applied, baked polyester powder coating or other equivalent protective coating.
 - 2.1.7 Unless shown otherwise, fan wheels handling more than 472 L/s (1000 cfm) shall be of the non-overloading backward inclined centrifugal type. Wheel hub shall be keyed and securely attached to the fan shaft. The wheel and fan inlet shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency. The assembled wheel shall be electronically balanced both statically and dynamically to balance grade G6.3 per ANSI S2.19.
 - 2.1.8 Each fan shall be provided with fan sheave, motor sheave, matched V-belts and belt guard.
- .1 Belt guard shall be OSHA compliant and completely cover the motor pulley and belt(s).
 - .2 Where motor is 7.5 kW (10 hp) or less, motor sheave shall be variable pitch.
 - .3 Where motor exceeds 7.5 kW (10 hp) motor sheave shall be variable pitch, to be replaced with a correctly sized fixed pitch sheave after balancing.
 - .4 Motors shall be in accordance with the requirements of Section 15054 – ELECTRIC MOTORS. See Schedule for hp (wattage) ratings.
 - .5 Belt drive motor shall have adjustable motor plate utilizing threaded studs for positive belt tensioning. Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150% of the installed motor horsepower.
 - .6 All fans, with the exception of utility fans, shall have arrangement 3 drive or arrangement 2 drive for smaller fans.

- 2.1.9 Permanently lubricated bearings are not acceptable. Bearings on shafts 24 mm (15/16 in.) diameter and larger shall be pillow block, self-aligning ball or roller bearings with seals and grease nipple. In addition, bearings on shafts 36.5 mm (1-7/16 in.) diameter and larger shall have grease nipple and grease relief valve. Bearings on shafts smaller than 24 mm (15/16 in.) diameter shall be pillow block, self-aligning ball bearings with seals and with grease nipple. Make all bearings accessible for lubrication and service, unless otherwise permitted by Owner. Where it is difficult to provide such access, provide extended lubrication lines. When such lines extend to pillow block bearings, provide a grease relief valve. Bearings shall be selected for a minimum L50 life in excess of 200,000 hours at maximum load.
- 2.1.10 Blower shaft shall be accurately turned and polished steel. Shaft shall be sized for a critical speed of at least 125% of the maximum RPM. The ends of fan shafts shall be centered depressions to allow for mechanical tachometer readings.
- 2.1.11 All fans, without ducts or dampers on the inlet or outlet, including fans in plenums, shall have protective screens on the openings.
- 2.1.12 Provide access doors on the fan scroll. Doors shall be hinged, in reinforced angle frames and provided with clamping devices. Minimum size shall be 450 mm x 350 mm (18 in. x 14 in.) or full width of fan scroll, if scroll is less than 450 mm (18 in.) wide.
- 2.1.13 Provide drain connections as shown. Drains shall be minimum 25 mm (1 in.) pipe size, half coupling, welded into the bottom of the scroll with a square headed, threaded, brass plug. Drain shall be extended clear of fan scroll.
- 2.1.14 Vibration isolation shall be provided as specified in Section 15200 – VIBRATION AND NOISE CONTROL.
- 2.1.15 Utility fans shall conform to the Specification for centrifugal fans above with the exception of the drive arrangement and belt guard. Drive shall be standard utility arrangement and belt guard may be omitted if a hood is provided over the drive.
- 2.1.16 Fans shall be suitable for operation with variable frequency drives where indicated in the Fan Schedule or as required to meet the requirements of Section 15951 – SEQUENCES OF OPERATION.
- 2.1.17 Fans with VFDs shall be complete with grounding rings.
- 2.1.18 Provide aluminum wheels where required to meet motor horsepower indicated on Fan Schedule.
- 2.1.19 Centrifugal fans shall be in accordance with the Fan Schedule.

3 Execution

3.1 INSTALLATION

- 3.1.1 Install fans in locations shown on plans.
- 3.1.2 Align shafts, belt drive and motor, adjust belt tension, ensure all set screws are tight and check motor rotation before start-up.
- 3.1.3 Protect motors and fans during construction.

END OF SECTION

1 GENERAL

1.1 RELATED REQUIREMENTS

- 1.1.1 Section 23 01 10 - Mechanical General Provisions.
- 1.1.2 Section 23 01 20 - Mechanical Submittals.
- 1.1.3 Section 23 05 93 - Testing Adjusting and Balancing.

1.2 PRODUCT DATA

- 1.2.1 Submit product data in accordance with Section 23 01 20 - Mechanical Submittals.
- 1.2.2 Indicate the following:
 - 1.2.2.1 Capacity.
 - 1.2.2.2 Throw and terminal velocity.
 - 1.2.2.3 Noise criteria.
 - 1.2.2.4 Pressure drop.
 - 1.2.2.5 Neck velocity.

1.3 MAINTENANCE MATERIALS

- 1.3.1 Provide maintenance materials in accordance with Section 23 01 10 - Spare Parts.
- 1.3.2 Include:
 - 1.3.2.1 Keys for volume control adjustment.
 - 1.3.2.2 Keys for air flow pattern adjustment.

1.4 MANUFACTURED ITEMS

- 1.4.1 Grilles, registers and diffusers shall be product of one manufacturer for generic type.

1.5 CERTIFICATION OF RATINGS

- 1.5.1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- 2.1.1 Grilles, Registers and Diffusers: E.H. Price, Titus, Barber Coleman, Hart and Cooley, Kreuger, Nailor.

2.2 GENERAL

- 2.2.1 Standard product to meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity as indicated.
- 2.2.2 Concealed operators.
- 2.2.3 Colour: As Indicated.
- 2.2.4 Acceptable material: As indicated.

2.3 SUPPLY GRILLES

- 2.3.1 General: with concealed manual operator and gaskets.
- 2.3.2 Steel, 25 mm border, double deflection with airfoil shape, horizontal face and vertical rear bars.

2.4 RETURN AND EXHAUST GRILLES

- 2.4.1 General: with opposed blade dampers on exhaust grilles, concealed manual operator and gaskets.
- 2.4.2 Steel or aluminium (as noted), 19 mm border, single 45E deflection, horizontal face bars.

2.5 DIFFUSERS

- 2.5.1 General: volume control dampers with flow straightening devices and blank-off quadrants and gaskets.
- 2.5.2 Steel, round type, having adjustable pattern, surface mounted.
- 2.5.3 Steel, square type, having fixed pattern, lay-in and or surface mounted.

2.6 NOISE CRITERIA

- 2.6.1 Grille, register and diffuser shall be sized to meet acceptable noise level indicated in the table below.

Space	Noise Level NC/RC
Auditorium	20-25
Cafeteria	40
Classrooms	25-30
Computer Rooms	35
Conference Rooms	30
Corridors	40
Gymnasium	35
Home Economics	30
Industrial Arts	35
Kitchen	45
Laboratories	30
Library	30
Locker Rooms	45
Music Room	30
Office	35
Reception	35
Server Room	45
Staff Room	40
Storage Rooms	45
Washrooms	45

3 EXECUTION

3.1 INSTALLATION

- 3.1.1 Install in accordance with manufacturers instructions.
- 3.1.2 Install with oval head cadmium plated screws in countersunk holes where fastenings are visible.
- 3.1.3 Bolt grilles, registers and diffusers, in place, in gymnasium and similar game rooms.

END OF SECTION

1 GENERAL

1.1 RELATED REQUIREMENTS

1.1.1 Section 23 01 10 - Mechanical: General Provisions.

1.1.2 Section 23 01 20 - Mechanical: Submittals.

1.2 REFERENCES

1.2.1 ANSI/NFPA 96-1987, Vapor Removal from Cooking Equipment.

1.2.2 ASTM E90-87, Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.

1.3 PRODUCT DATA

1.3.1 Submit product data in accordance with Section 23 01 20 - Mechanical Submittals.

1.4 CERTIFICATION OF RATINGS

1.4.1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

1.5 TEST REPORTS

1.5.1 Submit certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E90.

2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

2.1.1 Louvers: Airolite, E.H.Price, Westvent, Ruskin.

2.2 STATIONARY LOUVRES

2.2.1 Construction: welded with exposed joints ground flush and smooth.

2.2.2 Material: extruded aluminum alloy 6063-T5.

2.2.3 Blade: stormproof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of 1500 mm.

2.2.4 Frame, head, sill and jamb: 150 mm deep one piece extruded aluminum, minimum 3 mm thick with approved caulking slot, integral to unit.

2.2.5 Mullions: at 1500 mm maximum centres.

- 2.2.6 Fastenings: stainless steel (Society of Automotive Engineers) SAE-194-8F with SAE-194- SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, ss washer and aluminum body.
- 2.2.7 Screen: 12 mm exhaust 19 mm intake mesh, 2 mm diam wire aluminum birdscreen on inside face of louvres in formed U-frame.
- 2.2.8 Finish: factory applied enamel, Colour: to Architect's approval.
- 2.2.9 Acceptable material: Airolite CB6776.

3 EXECUTION

3.1 INSTALLATION

- 3.1.1 In accordance with manufacturers and SMACNA recommendations.
- 3.1.2 Reinforce and brace air vents, intakes and goosenecks to withstand local wind speeds as indicated.

END OF SECTION

1 GENERAL

1.1 RELATED WORK

- 1.1.1 Section 23 01 10 - Mechanical General Provisions.
- 1.1.2 Section 23 01 20 - Mechanical Submittals.
- 1.1.3 Section 23 73 13 - Built up Air Handling Units.

1.2 REFERENCES

- 1.2.1 ASHRAE 52-76, "Method of Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter".
- 1.2.2 ULC C710-1980, "Grease Extractors for Exhaust Ducts".
- 1.2.3 CAN4-S111-M80, "Fire Tests for Air Filter Units".
- 1.2.4 CAN/CGSB-115.10-M80 Filters, Air, Disposable, for Removal of Particulate Matter from Ventilating Systems.
- 1.2.5 CAN/CGSB-115.11-M85 Filters, Air, High Efficiency, Disposable, Bag Type (Reaffirmed April 1985).
- 1.2.6 CAN/CGSB-115.12-M85 Filters, Air, Medium Efficiency, Disposable, Bag Type (Reaffirmed April 1985)
- 1.2.7 CAN/CGSB-115.13-85 Filter Media, Automatic Roll (Reaffirmed April 1985)
- 1.2.8 CAN/CGSB-115.14-M80 Filters, Air Cartridge Type, High Efficiency, Supported, for Removal of Particulate Matter from Ventilating Systems
- 1.2.9 CAN/CGSB-115.15-M80 Filter, Air, High Efficiency, Rigid Type, for Removal of Particulate Matter from Ventilating Systems
- 1.2.10 CAN/CGSB-115.16-M82 Activated Carbon for Odor Removal from Ventilating Systems
- 1.2.11 CAN/CGSB-115.18-M85 Filter, Air Extended Area Panel Type, Medium Efficiency

1.3 SHOP DRAWINGS AND PRODUCT DATA

- 1.3.1 Submit shop drawings and product data in accordance with Section 23-01 20-Mechanical Submittals.
- 1.3.2 Indicate the following: Filters, mounting frames and 1.

1.4 MAINTENANCE DATA

- 1.4.1 Provide maintenance data for incorporation into manual specified in Section 23 01 20 - Mechanical Submittals.

1.5 CERTIFICATION OF RATINGS

- 1.5.1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

2 PRODUCTS

2.1 ACCEPTABLE MATERIAL

- 2.1.1 Filters: AAF, Cambridge, Farr.

2.2 GENERAL

- 2.2.1 Filters: suitable for air at 100% RH and air temperatures between minus 40 and 50 Deg.C.
- 2.2.2 Number of units, size and thickness of panels, overall dimensions of filter bank, configuration and capacities: as indicated.

2.3 ACCESSORIES

- 2.3.1 Holding frames: 1.6 mm thick channel section construction of galvanized steel or extruded aluminum.
- 2.3.2 Seals: to ensure leakproof operation.
- 2.3.3 Blank-off plates: as required, to fit all openings and of same material as holding frames.
- 2.3.4 Access and servicing: through doors/panels on each side and/or from upstream or downstream face of filter bank.

2.4 COTTON PANEL FILTERS

- 2.4.1 Disposable pleated reinforced 2 dry media: to CAN/CGSB 115.18.
- 2.4.2 Permanent galvanized steel holding frame or slide in channel for side access.
- 2.4.3 Efficiency: 30% to ASHRAE 52.
- 2.4.4 Fire rated: to CAN4-S111.
- 2.4.5 Nominal thickness: 50 mm.

2.4.6 Standard of Acceptance: Farr 30/30.

2.5 AIR FILTER GAUGES

2.5.1 Dial type: diaphragm actuated, direct reading.

2.5.2 Range: 0 – 250 Pa.

2.5.3 One for each bank of filters.

2.5.4 Permanent markers for initial pressure drop and manufacturer's recommended final pressure drop.

2.5.5 Standard of Acceptance: Dwyer 2000 series gauge.

3 EXECUTION

3.1 INSTALLATION GENERAL

3.1.1 Install in accordance with manufacturers recommendations.

3.2 REPLACEMENT MEDIA

3.2.1 Replace all media with new upon acceptance.

3.2.2 Filter media to be new and clean, at time of acceptance.

3.3 SPARE FILTER MEDIA

3.3.1 Furnish in accordance with Section 23 01 10 - Mechanical General Requirements.

END OF SECTION

1 GENERAL

1.1 RELATED REQUIREMENTS

1.1.1 Section 23 01 10 - Mechanical General Requirements

1.1.2 Section 23 01 20 - Mechanical Submittals.

1.2 SHOP DRAWINGS AND PRODUCT DATA

1.2.1 Submit shop drawings and product data in accordance with Section 23 01 20 - Mechanical Submittals.

1.2.2 Clearly indicate following:

1.2.2.1 Methods of sealing sections.

1.2.2.2 Methods of expansion.

1.2.2.3 Details of thimbles.

1.2.2.4 Supports.

1.2.2.5 Guy details.

1.2.2.6 Rain caps.

1.3 MAINTENANCE DATA

1.3.1 Provide maintenance data for incorporation into manual specified in Section 23 01 20 - Mechanical Submittals.

1.4 CERTIFICATION OF RATINGS

1.4.1 Catalogued or published ratings shall be those obtained from tests carried out by independent testing agency or manufacturer signifying adherence to codes and standards.

2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

2.1.1 Chimneys: Selkirk Metalbestos, Van Packer, Ecco.

2.2 BREECHINGS

2.2.1 Shop fabricated 3.5 mm thick mild steel, with sweep bends from boiler outlet to thimble or chimney as indicated.

2.3 TYPE B GAS VENT

2.3.1 ULC labelled, 288 deg.C rating maximum, atmospheric gas vent only.

2.3.2 Sectional, prefabricated, double wall with 13 mm air space. Aluminum inner wall. Galvanized steel outer wall. Mated fittings and couplings.

2.3.3 Acceptable material: Selkirk Metalbestos.

2.4 ALL FUELS PRESSURE CHIMNEY AND BREECHING

2.4.1 ULC labelled, 760 deg.C rated, all fuels.

2.4.2 Sectional, prefabricated, double wall with air space mineral wool insulation with mated fittings and couplings.

2.4.2.1 Liner: type 304 316 stainless steel.

2.4.2.2 Shell: type 304 316 stainless steel aluminized steel.

2.4.2.3 Outer seals between sections: to suit application.

2.4.2.4 Inner seals between sections: to suit application.

2.4.3 Acceptable material: Selkirk Metalbestos.

2.5 ACCESSORIES

2.5.1 Cleanouts: bolted, gasketed type, full size of breeching, as indicated.

2.5.2 Hangers and supports: in accordance with recommendations of SMACNA as indicated.

2.5.3 Rain cap.

3 EXECUTION

3.1 INSTALLATION - GENERAL

3.1.1 Follow manufacturer's and SMACNA installation recommendations for shop fabricated components.

3.1.2 Suspend breeching at 1.5 m centres and at each joint.

3.1.3 Support chimneys at bottom, roof and intermediate levels as indicated.

3.1.4 Install thimbles where penetrating roof, floor, ceiling and where breeching enters masonry chimney. Pack annular space with asbestos rope.

3.1.5 Install flashings on chimneys penetrating roofs, as indicated.

3.1.6 Install rain caps and cleanouts, as indicated.

END OF SECTION

1. GENERAL

1.1. REFERENCES

- 1.1.1. American Bearing Manufacturer's Association (ABMA)
- 1.1.2. ANSI/ABMA 9 Load Ratings and Fatigue Life for Ball Bearings.
- 1.1.3. ANSI/ABMA 11 Load Ratings and Fatigue Life for Roller Bearings.
- 1.1.4. Air Movement and Control Association (AMCA)
- 1.1.5. AMCA 210, Laboratory Method of Testing Fans for Aerodynamic Performance Rating (ASHRAE).
- 1.1.6. AMCA 300 Reverberant Room Method for Sound Testing of Fans.
- 1.1.7. American National Standards Institute/Air-Conditioning and Refrigeration Institute (ANSI/ARI)
- 1.1.8. ANSI/ARI 430, Central Station Air Handling Units.
- 1.1.9. American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE)
- 1.1.10. ASHRAE 68, Laboratory Method of Testing to Determine the Sound Power in a Duct.
- 1.1.11. ASHRAE 84, Method of Testing Air-to-Air Exchangers.
- 1.1.12. Canadian General Standards Board (CGSB)
- 1.1.13. CAN/CGSB 1.181, Ready-Mixed Organic Zinc-Rich Coating.
- 1.1.14. Canadian Standards Association (CSA)
- 1.1.15. CSA B52 Mechanical Refrigeration Code.
- 1.1.16. National Electrical Manufacturer's Association (NEMA)
- 1.1.17. NEMA MG1 Motors and Generators
- 1.1.18. NEMA ICS 7-1 Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems.
- 1.1.19. Provincial Boiler, Pressure Vessel and Compressed Gas Regulations.
- 1.1.20. Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA).

1.2. SHOP DRAWINGS AND PRODUCT DATA

- 1.2.1. Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- 1.2.2. Indicate following: fan, fan curves showing point of operation, motor drive, bearings, filters, mixing box, dampers, VAV, coil, include performance data.

1.3. CLOSEOUT SUBMITTALS

- 1.3.1. Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- 1.3.2. Include following: fan, bearings, motor, damper, VAV control, air volume, total cooling, sensible cooling, EDB,EWB, OAT.

1.4. WASTE MANAGEMENT AND DISPOSAL

- 1.4.1. Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal, and with the Waste Reduction Workplan.
- 1.4.2. Remove from site and dispose of packaging materials at appropriate recycling facilities. Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- 1.4.3. Divert unused metal and wiring materials from landfill to metal recycling facility approved by Owner's Representative.
- 1.4.4. Divert unused paint material from landfill to official hazardous material collections site approved by Owner's Representative.
- 1.4.5. Do not dispose of unused paint materials into sewer systems, into lakes, streams, onto ground or in other locations where it will pose health or environmental hazard.

1.5. EXTRA MATERIALS

- 1.5.1. Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- 1.5.2. Provide one spare set of filters.
- 1.5.3. Provide list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.
- 1.5.4. Spare filters: in addition to filters installed for startup and commissioning. Immediately prior to acceptance by Owner's Representative, supply 1 complete set of filters for each filter unit or filter bank.

2. PRODUCTS

2.1. GENERAL

- 2.1.1. Heat exchanger, cross-flow type made of aluminum.
- 2.1.2. Unit to be self contained with all necessary controls and wiring to facilitate a single point connect. Provide disconnect and vibration isolators.

2.2. CABINET, FANS AND FILTERS

- 2.2.1. Casing: galvanized, pre-painted steel with foil faced insulation. Double wall construction.
- 2.2.2. Provide full size access doors to allow for periodic maintenance and inspection. Door construction, same as unit with compression type handles and resilient gaskets.

- 2.2.3. Drain pans to be formed sections, recessed, fabricated from 1.2 mm stainless steel 304. Piped to nearest floor drain.
- 2.2.4. Fans: centrifugal type with double blowers and motors rated for single phase 208 V. Separate Motor for the supply and exhaust fan.
- 2.2.5. Filers: medium efficiency in the supply and exhaust air streams.
- 2.2.6. Defrost: exhaust.
- 2.2.7. Provide automatic recirc defrost cycle.
- 2.2.8. Capacity: 35.4 L/s @50 Pa, 1.5 kW electric slip in duct heater with duct mounted thermostat. Electrical requirements 120/1/60, 1.5A, 160W.

3. EXECUTION

3.1. INSTALLATION

- 3.1.1. Install units in accordance with manufacturer's instructions and as indicated.
- 3.1.2. Ensure adequate clearance for servicing and maintenance.

3.2. FANS

- 3.2.1. Install fan sheaves required for final air balance.
- 3.2.2. Install flexible connections at fan inlet and fan outlets.
- 3.2.3. Install vibration isolators.

3.3. DRIP PANS

- 3.3.1. Install deep seal P-traps and trap seal primer on drip lines.
- 3.3.2. Depth of water seal to be 1.5 times static pressure at this point.

END OF SECTION

General

1.1 RELATED REQUIREMENTS

- 1.1.1 25 01 11 - EMCS Start-up and Testing
- 1.1.2 26 08 10 - Electrical Start-up and Testing – General Requirements
- 1.1.3 26 08 40 - Electrical Equipment and Systems - Demonstration and Instruction

1.2 CERTIFICATION AND STANDARDS

- 1.2.1 Products covered by this section to comply to the applicable standards of the following:
 - 1.2.1.1 CSA C22.2 No.14-95 Industrial Control Equipment
C22.2 No.100-95 Motors and Generators
C22.2 No.0.16-M92 Measurement of Harmonic Currents
 - 1.2.1.2 EEMAC Standards for Enclosures, Contact Ratings and Design B Motors
 - 1.2.1.3 IEEE 519 M1992 Recommended Practices and Requirements for Harmonic Control in Electric Power Systems, Emerald Book for Transients
 - 1.2.1.4 NEMA MG1 Part 31 1993 Rev 1 Motors and Generators

1.3 SHOP DRAWINGS

- 1.3.1 Provide [six] copies of shop drawings and operating literature.
- 1.3.2 Shop drawings shall include:
 - 1.3.2.1 Catalogue information and technical data
 - 1.3.2.2 Outline dimensions, shipping dimensions, weight, foundation requirements and mounting details.
 - 1.3.2.3 Wiring, connection, and control diagrams and schematics
- 1.3.3 Product data for:
 - 1.3.3.1 input current harmonics,
 - 1.3.3.2 short circuit rating,
 - 1.3.3.3 environmental limitations
 - 1.3.3.4 control features.

1.4 OPERATING AND MAINTENANCE INFORMATION

- 1.4.1 Upon interim acceptance, provide three sets of operating and maintenance manuals including:
 - 1.4.1.1 Operating instructions
 - 1.4.1.2 As built shop drawings
 - 1.4.1.3 Recommended spare parts list
 - 1.4.1.4 Manufacturer and supplier data: including addresses and phone numbers for technical support and spare parts.

1.5 SUPPLIER QUALIFICATIONS

- 1.5.1 System supplier or manufacturer's authorized agent shall have technical service and maintenance capabilities, using experienced personnel, available on site within 24 hours of callout.

2 Products

2.1 PRODUCT MANUFACTURERS

2.1.1 Acceptable Manufacturers:

- 2.1.1.1 Siemens
- 2.1.1.2 Danfoss
- 2.1.1.3 Toshiba
- 2.1.1.4 Magnetek
- 2.1.1.5 Allen Bradley
- 2.1.1.6 Mitsubishi

2.2 VARIABLE FREQUENCY DRIVES

2.2.1 General

- 2.2.1.1 Drive Type: Adjustable Frequency Drive, Pulse Width Modulated (PWM)
- 2.2.1.2 Output Devices: Insulated Gate Bipolar Transistors (IGBT) in the inverter section of the drive
- 2.2.1.3 All contactors, relays and switches EEMAC rated.
- 2.2.1.4 All drives of a single manufacture

2.2.2 Motor and Drive Compatibility:

- 2.2.2.1 Suitable for use with standard or high efficiency EEMAC Design B motors having a service factor of 1.15 or specific motors meeting NEMA MG1 Part 31, 1993 Rev.1.
- 2.2.2.2 Suitable for either constant or variable torque loads.
- 2.2.2.3 Operable without connected load for setup and testing.
- 2.2.2.4 Able to accept opening of a remote motor disconnect, while running, without damage to the drive.

2.2.3 Enclosure: EEMAC 1 [wall] [floor] mounted

2.2.4 Voltage:

- 2.2.4.1 Input: [208] [480] [600] volts nominal, $\pm 15\%$; 3 phase; 60 Hz ± 3 Hz. Refer to related equipment for required voltage.
- 2.2.4.2 Output: [208] [480] [600] volts, 3 to 66 Hz, 3 phase, with volts per hertz compensation. Refer to related equipment for required voltage.
- 2.2.4.3 Transformers: Do not use transformers on either the input or output for voltage compliance.

2.2.5 Rating:

- 2.2.5.1 Power: Horsepower or Kilowatt ratings as specified in the Equipment Schedule.

- 2.2.5.2 Service Factor: 1.1 for rated output current, continuous duty
- 2.2.5.3 Thermal: 130% of rated output current for one minute.
- 2.2.5.4 Efficiency: 97% minimum at maximum load and speed.
- 2.2.5.5 Power Factor: 0.95 minimum line side at all speeds.
- 2.2.5.6 Harmonic Distortion: Total Harmonic Distortion (THD) for Input current generally not to exceed the requirements of IEEE 519 M1992 where the point of common coupling is considered to be where the drive connects to the system and specifically not to exceed:
 - 2.2.5.6.1 10% for drives 100 HP and larger
 - 2.2.5.6.2 12% for drives between 50 and 100 HP
 - 2.2.5.6.3 15% for drives under 50 HP.
- 2.2.5.7 Short Circuit: Drive capable of withstanding short circuit of 50,000 amps, asymmetric at line side terminals.
- 2.2.6 Drive Protection: Provide the following protection:
 - 2.2.6.1 Transients: Input transient protection for IEEE Class B ringwave.
 - 2.2.6.2 Voltage: Line over and under voltage, phase loss and phase unbalance.
 - 2.2.6.3 Short Circuit: Line to line and line to ground.
Drive to shut down without damaging any power circuit devices on either of these faults. Do not use fuses or isolation transformers to provide this protection.
 - 2.2.6.4 Overcurrent: electronic, instantaneous
 - 2.2.6.5 Current Limit: adjustable for 70 to 110% rated current.
 - 2.2.6.6 Internal controller over-temperature.
- 2.2.7 Ambient Conditions: The drive shall operate satisfactorily under the following ambient conditions
 - 2.2.7.1 Temperature: 0 to 40°C.
 - 2.2.7.2 Humidity: 5 to 90% non-condensing.
 - 2.2.7.3 Altitude: up to 1000m without drive derating
- 2.2.8 Controls: Provide the following controls and adjustments:
 - 2.2.8.1 Minimum speed: 0 - 70%, adjustable.
 - 2.2.8.2 Maximum speed: 50 - 150%, adjustable.
 - 2.2.8.3 Acceleration /deceleration ramp: 1 to 300 seconds (0 to 100% speed), adjustable, linear or S curve.
 - 2.2.8.4 Speed and load meter: 0 to 100% with selector switch, door mounted
 - 2.2.8.5 Run and Stop push buttons, door mounted
 - 2.2.8.6 Hand-off-auto selector switch, door mounted
 - 2.2.8.7 Keypad speed setting, door mounted.
- 2.2.9 Motor Protection: Provide the following motor protection features:
 - 2.2.9.1 Overload: Provide thermal or solid state overload protection, adjustable from 80% to 115% of full load rating. For drives feeding multiple motors, provide individual motor overloads.
 - 2.2.9.2 Over temperature: Provide positive temperature coefficient (PTC) thermister protection for motors identified in the Equipment Schedule.
 - 2.2.9.3 Stall protection: electronic, to trip the drive off under motor stall conditions.

- 2.2.9.4 Automatic restart: after an inverter fault trip the drive shall attempt to restart automatically three times and lock out after the third attempt if a restart has not occurred.
- 2.2.9.5 Rotating motor restart: The drive shall restart a rotating motor without first stopping it for short duration power outages, shut downs or fault trips by resynchronizing with the motor at its rotating speed and re-accelerating it to setpoint speed.
- 2.2.9.6 Output Filter: For drives of 100 HP and larger, provide an RLC output filter network to limit dv/dt or provide data showing that a filter is not required for the specific motor being driven.
- 2.2.10 Control Interface: Provide the following control interfaces:
 - 2.2.10.1 4-20 mA or 0-10 VDC signal follower switchable to inverse characteristics
 - 2.2.10.2 Dry contact closure for run command
 - 2.2.10.3 Dry contact (N.O.) output to indicate:
 - 2.2.10.4 Inverter Fault
 - 2.2.10.5 Inverter Running (motor turning)
 - 2.2.10.6 4-20 mA isolated output, proportional to speed
 - 2.2.10.7 4-20 mA isolated output, proportional to load
 - 2.2.10.8 signal follower to interface with the Energy Management Control System (EMCS)
- 2.2.11 Status: Provide on line status information. Display each of the following status points by a separate pilot light or LCD display on the controller door:
 - 2.2.11.1 Start Command Present
 - 2.2.11.2 External Trip (interlocks open)
 - 2.2.11.3 Lockout (fault shutdown after 3 restart attempts)
 - 2.2.11.4 Ready (power on - no faults present)
 - 2.2.11.5 Power On
 - 2.2.11.6 Low reference (missing or zero speed reference)
 - 2.2.11.7 Motor Running Direction
 - 2.2.11.8 Inverter in current limit
- 2.2.12 Fault Diagnostics: Provide diagnostics which memorize and display the last ten fault occurrences even after the drive restarts. Indicate each of the following faults by a separate pilot light or LCD display on the controller door:
 - 2.2.12.1 Stop called for or start error
 - 2.2.12.2 External trip (interlock opened)
 - 2.2.12.3 Controller over temperature
 - 2.2.12.4 Emergency stop
 - 2.2.12.5 High DC Bus
 - 2.2.12.6 Output transistor fault
 - 2.2.12.7 Low DC Bus
 - 2.2.12.8 Current Overload
- 2.2.13 Indicators: Provide additional LED's or other diagnostics to allow signal tracing of logic and base driver circuit boards.

- 2.2.14 Interlocks: Provide external interlock for firestat, freezestat, smoke detector or other devices as indicated in the Equipment Schedule. Common interlock to cause motor to coast to stop.

2.3 SYSTEM OPERATION:

- 2.3.1 Motor to start when the selector switch is in the "auto" position and the run command is received from the control system. Speed to be controlled by the control signal.
- 2.3.2 Motor to start when the door mounted run pushbutton is depressed when the selector switch is in the "manual" position. Speed to be controlled by the door mounted manual speed control.
- 2.3.3 Motor to automatically restart after a power outage when the power returns, if the run command is maintained. After short duration outages, motor to be restarted while rotating.
- 2.3.4 Motor to restart automatically, with up to 3 attempts, in the event of an inverter trip. Drive to lock out after 3 unsuccessful attempts.

2.4 OVERCURRENT PROTECTION

- 2.4.1 Provide incoming fused line disconnect switch or circuit breaker with the following:
 - 2.4.1.1 Door interlock
 - 2.4.1.2 Provisions for padlocking operating mechanism
 - 2.4.1.3 Overcurrent curves for fuses or circuit breakers coordinated with the drive's output protection. Fuses not to blow or breakers trip under output faults such as overcurrent, short circuit and ground fault

3 Execution

3.1 MOTORS

- 3.1.1 Ensure that the motors fed from the drives are compatible with the drives, including load rating, voltages and thermistor protection.

3.2 INSTALLATION

- 3.2.1 Set and secure the drives in place on channel bases, rigid, plumb and square to the building floors and walls.
- 3.2.2 For drives 100 HP and larger, locate drive so that conductors from drive to motor are less than 10m long.
- 3.2.3 Provide two hold down bolts for each 1m linear width.
- 3.2.4 Protect drives from dust and damage during construction.
- 3.2.5 After connections are made, vacuum clean interior, hand clean exterior and touchup any damaged paint.
- 3.2.6 Comply with requirements of Sections 26 08 10 and 26 08 40.

3.3 START-UP AND TESTING

- 3.3.1 For drives 100 HP and larger, provide the services of a manufacturer trained technician, on the site, to review the installation and assist in the set up, starting and testing of the drives. Allow a minimum of four hours on site per drive.
- 3.3.2 Set up the drive prior to energizing. Set up to include initial settings for all adjustable parameters.
- 3.3.3 Function test the drive prior to interim acceptance. Test shall include:
 - 3.3.3.1 functional testing of all safety devices
 - 3.3.3.2 start, run up, signal tracking, stop and hot restart
 - 3.3.3.3 load test using the connected load, run through available load and speed range
 - 3.3.3.4 test of control sequences
 - 3.3.3.5 snapshot of harmonic content for input and output current at 100% and 50% load

3.4 DEMONSTRATION AND INSTRUCTION

- 3.4.1 For drives 100 HP and larger, provide operator training, on site, using manufacturer trained personnel.
- 3.4.2 Training to include the following topics:
 - 3.4.2.1 Drive theory
 - 3.4.2.2 Drive configuration and models installed
 - 3.4.2.3 Set up for each drive type
 - 3.4.2.4 Maintenance
 - 3.4.2.5 Troubleshooting

End of Section

1. GENERAL

1.1. WORK INCLUDED

- .1 Provide all labour, materials, products, equipment and services to supply, install, test and commission Building Automation System (BAS) with Direct Digital Control (DDC) for building mechanical and electrical systems and interface with other microprocessor based building subsystems as indicated on drawings and described herein.
- .2 Conform to Section 21 05 00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. RELATED SECTIONS

- .1 Section 01 60 00.00 – BASIC PRODUCT REQUIREMENTS
- .2 Section 21 05 14.00 – WIRING AND STARTERS.
- .3 Section 21 08 00 – COMMISSIONING.
- .4 Section 26 05 01.00 – ELECTRICAL GENERAL REQUIREMENTS.
- .5 Section 26 05 34 – CONDUIS, CONDUIT FASTENINGS AND CONDUIT FITINGS

1.3. SYSTEM OUTLINE

- .1 General
 - .1 The documentation contained in this section and other contract documents pertaining to Building Automation System (BAS) is schematic in nature. The contractor shall provide all required hardware and software necessary to implement the functions shown or implied in the contract documents.
 - .2 Control system to consist of integral controller factory install on equipment. Equipment controller shall be electronic and provide minimum features of the specified equipment. Equipment controller shall have a web-based operator interface.
 - .3 Operators shall access the system through web browser and browser interface to perform normal operator functions.
 - .4 BAS to operate on building LAN communication infrastructure. Provide ethernet connection to equipment controller where required.
- .2 Functional Principals

-
- .1 BAS to control mechanical and electrical equipment as specified in CONTROL SEQUENCES, SCHEMATICS AND EQUIPMENT SCHEDULES.

1.4. CODES AND STANDARDS

- .1 Comply with rules and regulations of codes and ordinances of local, provincial, and federal authorities; such codes and ordinances, when more restrictive, take precedence over the Contract Documents.
- .2 Provide products listed and classified by the testing firm acceptable to the authority having jurisdiction as suitable for the purpose indicated and specified.

1.5. STANDARD OF EQUIPMENT

- .1 Use only new products and software that manufacturer is currently stocking and selling for use in new installations.
- .2 Do not use this installation as product test site unless explicitly approved in writing.
- .3 Spare parts, software and technical support to be available for at least ten years after acceptance is certified.

1.6. OPEN PROTOCOL STANDARD

- .1 Intention of this specification is to provide an integrated, open protocol BAS, BACnet as defined by ANSI/ASHRAE standard 135-2008.
- .2 BACnet devices on the lower tier network to support all BACnet functional groups, standard application services and standard object types necessary, but not limited to provide reading and writing functionality of all analog and binary inputs and outputs and change-of-value initiation and reporting between BACnet devices on the network.
- .3 All BACnet devices to be BTL tested. Provide Protocol Implementation Conformance Statement (PICS) for all BACnet devices.

1.7. SUBMITTALS

- .1 Product Data and Shop Drawings:
 - .1 Within 30 days of award of contract, before start of construction, submit completely engineered and coordinated shop drawing package.
 - .2 To Division 1 – Submittals in printed format and as amended below.
 - .3 Provide drawing files on CD.
 - .4 Riser Diagrams: Indicate: communication wire paths and connections to network devices;

- power wire and ground wire connections to Operator Interfaces and network devices; wire types and port types with manufacturer's model numbers; communication protocol and communication speed for network segments; power panel and breaker designations; wire terminal designations; addresses for network devices; room designations.
- .5 Specifications and Instructions: Indicate: dimensions, capacities, electrical characteristics, mechanical characteristics, environmental characteristics, performance characteristics, finishes. Circle model number for products provided or furnished. General catalogue sheets are not acceptable. Provide installation instructions.
- .6 System Flow Diagrams: Indicate: control devices, control device designation, control device range, control device fail-safe position, point object type, point object name, point object address. Indicate flow directions for gases and liquids relevant to the controlled process. Indicate hardwired interlocks between control devices and equipment. Indicate the location of field control devices.
- .7 Products Schedule: Indicate: product designation, product name, product manufacturer, product model number, product data sheet reference number, quantities. Provide quantities required under the Work.
- .8 Valve Schedule: Indicate: system designation, control device designation, valve body size, pipe sizes, valve design flow, selected valve Cv, selected valve design flow pressure drop, valve body configuration, valve body model number, actuator fail-safe position, actuator model number, actuator quantity, actuator close-off pressure rating.
- .9 Damper Schedule: Indicate: system designation, control device designation, duct dimensions, blade width, blade type, damper model number, calculated torque, actuator torque, actuator model number, actuator quantity, actuator fail-safe position, provisions for edge and blade seals, actuator mounting configuration.
- .10 Room Schedule: Indicate: controller object name, controller address, controller model number, application designation, room designation, VAV air volume set points, sensor model numbers.
- .11 Cabinet Layouts: Interior: Indicate: orientation of contents including controllers, transformers, cable trays, terminal strips, relays, control devices, labels. Exterior: Indicate: orientation of gauges, displays, switches, labels.
- .12 Wire Details: Indicate: connections between control devices, controllers and equipment; connections to sources of power and grounds; control device designations, control device terminal designations, control device location; equipment terminal designations; cabinet terminal strip designations; wire designations. For control devices shown on multiple drawings, indicate the control device with the same designation on all drawings. Differentiate between manufacturer installed wire and field installed wire.
- .13 Sequence of Operation: Provide a complete description of operation to Section 23 09 23.00 – SEQUENCE OF OPERATION FOR BAS. Provide description of operation for interlocks that directly connect to the Work. Indicate references to the system flow diagram by control device designation or point object name.
- .14 Custom Application Programs (Algorithms): Provide in printed format to Section 23 09 23.00 – SEQUENCE OF OPERATION FOR BAS. Provide comments that describe the details of program functions.

- .15 Flow Diagrams for Custom Application Programs (Algorithms): Provide in printed format to Section 23 09 23.00 – SEQUENCE OF OPERATION FOR BAS.
- .16 Points Schedule: Indicate: input points, output points and virtual points for each controller. Indicate: point object address, point object name, point object description, point object alarm limits. List points in ascending order based on point object address.
- .2 Project Record Documents:
 - .1 Operation and Maintenance Manuals:
 - .1 Provide two copies in printed format for review by the Consultant at least ten weeks before the projected substantial completion date.
 - .2 Provide three copies of corrected manuals in printed format and three copies on CD within three weeks following completion of Acceptance Test under Part 3: Execution. Provide manuals in hard cover three-ring binders with index page and indexing tab per section.
 - .3 Sections:
 - .1 Contact Information: Provide names, addresses, 24-hour telephone numbers of service representatives and installing subcontractors.
 - .2 Operation: Provide owner operating manuals for Operator Interfaces, Controller Resident Software, DDC Controllers, Advanced Application Controllers, Specific Application Controllers, control devices, compressed air system. For Custom Application Programs (Algorithms) Editor, provide a reference manual for the language syntax that describes each function.
 - .3 Engineering, Installation and Maintenance: Provide manuals for design and installation of point objects, controllers, control devices. Provide instructions for calibrating, troubleshooting and replacing controllers and control devices.
 - .4 Software: Provide complete original issue media and release notes for Operator Interfaces.
 - .5 Preventive Maintenance Procedures: Provide for Operator Interfaces, controllers, control devices. Provide a schedule of tasks; indicate dates for inspection, maintenance and calibration; indicate the pages in the engineering, installation and maintenance manuals that list the procedures.
 - .6 Replacement Parts List: Indicate: manufacturer name, manufacturer model number, supplier name, supplier address, supplier telephone number.
 - .7 Certificates: Provide original issue certificates for installation, maintenance and calibration.
 - .8 Test Forms: Provide copies of test forms completed under Part 3: Execution, Testing and Commissioning.
 - .9 Provide licenses, guarantees and warranty documents for products and systems.
 - .2 As-built Product Data and Shop Drawings:

- .1 Provide three copies in printed format and three copies on CD for approval by the Consultant within three weeks following the successful completion of Acceptance Test under Part 3: Execution.
- .2 Provide drawing files on CD.
- .3 Points Schedule: For points schedule generated under Part 1: Submittals, Product Data and Shop Drawings, indicate operating conditions for point object data; list point objects by system designation and alphabetically by point object name.
- .4 Time-of-Day (TOD) Schedules: Indicate: objects assigned to the TOD Schedule, Occupied Mode times.
- .3 As-built Floor Plans:
 - .1 Maintain on the project site as-built conditions on one full-size set of Contract Drawings, referred to as Marked-up Drawings; indicate on these drawings as-built locations for: control devices, cabinets, network devices with network address, communication networks by type and address, connection points to communication networks for Operator Interfaces, power networks, conduit paths, junction boxes, Operator Interfaces.
 - .2 Submit three copies of Marked-up Drawings to Consultant for review within three weeks following successful completion of Acceptance Test under Part 3: Execution. Revise Contract Drawings to match the approved Marked-up Drawings; revise using AUTOCAD Release 12 or higher format and submit three copies as full-size in printed format and three copies of drawing files on CD.
- .3 Training Manuals:
 - .1 Provide a course outline, and one copy in printed format of training manuals provided under Part 3: Execution, Instruction and Training at least six weeks prior to the first class. Modify the course outline and training materials to suit Owner's requirements and as requested by the Consultant.

1.8. WARRANTY

- .1 Warrant the Work in accordance with the General Conditions and as amended below.
- .2 Warranty start date will be the date the Work is accepted under Part 3: Execution, Acceptance Test.
- .3 Provide a single warranty start date even when the Owner has received beneficial use prior to acceptance of the Work. For Work split into multiple contracts or for a multi-phase contract, provide a separate warranty start date and period for each contract or phase.
- .4 Adjust, repair or replace defects and failures in the Work at no additional cost during the warranty period and without reduction in service to the Owner. Provide warranty service during normal business hours and within 24 hours of the Owner's request for service.

-
- .5 Provide warranty service by factory trained service representatives of the Supplier.
 - .6 Replace Operator Interface software, Controller Resident Software, controller firmware and database files with revisions that correct deficiencies or defects during the warranty period at no charge to the Owner. Notify the Owner of changes and schedule the installation. Update Operation and Maintenance Manuals with firmware release notes.
 - .7 Prior to testing date under Part 3: Execution, Acceptance Test, update firmware in controllers to latest revisions at no additional cost to the Owner; update Operation and Maintenance Manuals with firmware release notes.
 - .8 During the Warranty period check the tuning of each control loop once during heating season and once during cooling season; notify the Owner when this work is to occur. Forward to the Consultant documentation indicating observations and adjustments made.
 - .9 Warrant products that are reconditioned under the Work to the same requirements as new products.

1.9. OWNERSHIP OF PROPRIETARY MATERIAL

- .1 Software and documentation supplied and generated under the Work or required for ongoing system operation, maintenance and modification becomes the property of the Owner, including and not limited to graphic files, database files, Custom Application Programs, Project Record Documents, Training Manuals.
- .2 Licensing to permit an unlimited number of users to access the system without additional fees.
- .3 As of last day of the warranty period, all software to be upgraded to most current recommended version of manufacturer's release.

2. PRODUCTS

2.1. MATERIALS

- .1 Existing Products: To Part 3: Execution, Existing Products.
- .2 New Products: Non-beta versions currently under manufacture and have been applied in similar installations for a minimum period of one year.
- .3 Revisions: Latest available revision for Operator Software, Controller Resident Software and controller firmware at start of Warranty.
- .4 Replacement Parts: Readily available and not scheduled for discontinuation at time of Total Project Completion.

- .5 Expansion: Expandable through additional inputs and outputs and to card access, security, fire alarm, lighting control systems and other building systems.

2.2. 3RD PARTY MANUFACTURER INTERFACE:

- .1 3rd party manufacturer controllers included but not limited to chillers, boilers, variable frequency drives, power monitoring, medical gasses to be based on the open system communication (BACnet) for seamless integration with BAS. Include network connection from BAS to 3rd party manufacturer controllers.
- .2 If open system controllers are not available, include appropriate hardware equipment and software to allow bi-directional data communication between the BAS and 3rd party manufacturers' control panels.

2.3. POWER SUPPLIES AND LINE FILTERING

- .1 Provide a separate power supply for every Building Controller, Advanced Application Controller and Application Specific Controller for terminal units.
- .2 Power Supplies:
 - .1 Type: Enclosed; Class 2 current-limiting, or over-current protection in primary and secondary circuits for Class 2 service to the National Electrical Code.
 - .2 Applied Loads: To 80% of rated capacity.
- .3 DC Power Supplies: Regulated output.
 - .1 Built in over voltage and over current protection.
 - .2 Able to withstand 150% current overload for at least 3 seconds without trip or failure.
- .4 Power Line Filtering: Provide internal or external transient voltage and surge suppression for workstations and controllers.

2.4. CABINETS

- .1 Type: NEMA rated and suitable for installed environment.
- .2 Door: Hinged with key-lock latch with common key for all cabinets; provide duplicate keys; for Application Specific Controllers provide screwed tight slide-off cover.
- .3 Controllers, transducers and relays mounted on backing board or DIN rails within inner section behind hinged doors.

2.5. CONTROL DEVICES

.1 Motorized Control Dampers:

.1 Sizing:

.1 Dimensions: As indicated. Maximum damper section size: 1200 mm x 1500 mm (48 in. x 60 in.). For dampers larger than the section maximum, use an assembly of multiple, equally sized sections.

.2 Two-position: Parallel blade.

.3 Modulating: Opposed blade. Parallel blade dampers may be used for return air and bypass applications.

.2 Frame: 125 mm x 25 mm x 3 mm (5 in. x 1 in. x 0.125 in.) 6063T5 extruded aluminum with mounting flanges on both sides.

.3 Blades: Airfoil shape, 6063T5 extruded aluminum, maximum 150 mm (6 in.) depth.

.4 Seals:

.1 Blade Edge: Extruded thermoplastic rubber (TPR) suitable for -58 deg. C to 135 deg. C (-72 deg. F to 275 deg. F), mechanically locked in place and easily replaceable in the field.

.2 Blade Jamb: Spring-loaded stainless steel.

.5 Bearings: Molded synthetic.

.6 Linkage: Corrosion resistant steel and concealed in the frame.

.7 Drive Shaft: Corrosion resistant steel of square or hexagon shape.

.8 Axle: Corrosion resistant steel.

.9 Leakage: Maximum 0.35 L/s/sq m (8 CFM/sq ft) at 1.0 kPa (4 in. w.g.) of differential pressure across fully closed damper when tested to AMCA Standard 511.

.10 Make and Model: Ruskin CD-50 or equivalent.

.2 Actuators For Dampers, Electronic:

.1 Control Signal: Compatible with BC, AAC and ASC.

.2 Floating control signal is acceptable only for VAV damper application.

.3 Operating Time: Maximum 120 seconds throughout the full rotation.

.4 Angle of Rotation: Adjustable between 0° to 90°.

.5 Stall protection: Mechanical or electronic.

.6 Actuators shall have electronic overload protection or digital rotation sensing circuitry to prevent actuator damage throughout the entire rotation.

.7 Failsafe: Non-spring return for VAV terminals; spring return for other applications. Spring return to normal position within 15 seconds.

.8 Manual Override: Crank type. External gear release for non-spring return actuators.

- .9 Position Indicator: Reversible for clockwise or counter-clockwise rotation; set the 0 degrees mark to the failsafe position.
- .10 Torque: To damper manufacturer's requirements to provide complete compression of seals between frame and blades and for smooth control.
- .3 Control Valves:
 - .1 Characteristics, materials and pressure ratings suitable for the application; refer to schedules.
 - .2 Flow Characteristic:
 - .1 Water:
 - .1 Two-way: Equal percentage.
 - .2 Three-way: A Port: Equal percentage. B Port: Linear or modified linear.
 - .2 Steam: Linear.
 - .3 Sizing Water Valves:
 - .1 Two-position: Line size with full ports.
 - .2 Two-way Modulating: Non Radiation: Pressure drop equal to the pressure drop through the coil or 27 kPa (4 psi), whichever is greater. Radiation: Pressure drop equal to 7 kPa (1 psi).
 - .3 Three-way Modulating: Non Radiation: Pressure drop equal to the pressure drop through the coil or 27 kPa (4 psi), whichever is greater. Radiation: Pressure drop equal to 7 kPa (1 psi).
 - .4 Butterfly Valves:
 - .1 Type: High-performance (HPBV).
 - .2 Make and Model: Dezurik BHP or equivalent.
 - .3 Tee-fitting: Provide for three-way application; with motor mounting bracket and linkage hardware.
 - .5 Valves 12 mm (1/2 in.) through 50 mm (2 in.):
 - .1 Screwed ANSI Class 250 bronze body.
 - .6 Valves 62 mm (2-1/2 in.) and Larger:
 - .1 Water temperature less than 121 deg. C (250 deg. F) at 1035 kPa (150 psi) or less than 93.2 deg. C (200 deg. F) at 1139 kPa (165 psi): Flanged ANSI Class 125 cast iron body.
 - .2 Water temperature greater than 121 deg. C (250 deg. F) at 1035 kPa (150 psi) or greater than 93.9 deg. C (200 deg. F) at 1138 kPa (165 psi): Flanged ANSI Class 250 cast iron body or ANSI Class 300 cast steel body.
- .4 Leakage: ANSI Class IV.
- .5 Materials:
 - .1 Stems: Stainless steel.
 - .2 Plugs and Seats: Brass or steel.

- .3 Packing: PTFE for steam.
- .6 Rangeability: 40:1 minimum.
- .7 Heating valves shall be modulating unless noted otherwise.
- .4 Actuators for Control Valves, Electronic:
 - .1 Control Signal: Compatible with BC, AAC and ASC.
 - .2 Floating control signal is not acceptable.
 - .3 Operating Time: Maximum 120 seconds throughout the full rotation.
 - .4 Mounting: Corrosion resistant hardware.
 - .5 Stall Protection: Electronic overload or digital rotation sensing.
 - .6 Failsafe: Non-spring return for radiation and terminal reheat coils; spring return for others. Spring returns to normal position within 15 seconds.
 - .7 Manual Override: Crank type. External gear release for non-spring return actuators.
 - .8 Position Indicator: Provide. Indicate valve open and closed positions.
 - .9 Close-off Pressure:
 - .1 Water:
 - .1 Two-way: 150% of total system head.
 - .2 Three-way: 300% of the pressure differential between ports A and B at design flow, or 100% of total system head.
 - .2 Steam: 150% of inlet pressure.
- .5 Electric Relays:
 - .1 Type: General purpose; enclosed coil; diodes provided for inductive switched loads; override button; LED "energized" indicator; plug-in type base.
 - .2 Contact rating, configuration and coil voltage suitable for application.
 - .3 Regulatory: UL listed.
- .6 Damper End Switches:
 - .1 Type: Lever operated activated by blade position.
 - .2 Electrical Contacts: Rated for 10 A resistive, 6 FLA at 120 VAC.
 - .3 Regulatory: UL listed.
- .7 Level Switches:
 - .1 Type: Float.
 - .2 Electrical Contacts: Rated for 10 A resistive, 6 FLA at 120 VAC.
 - .3 Mounting: Outside of fluid of measured fluid.
 - .4 Enclosure: NEMA rated for the application.

- .8 Low Limit Electromechanical Thermostat:
 - .1 Type: Vapour Pressure; minimum 6000 mm (20 ft.) of capillary; actuated by any 300 mm (12 in.) of capillary element; manual reset upon activation.
 - .2 Electrical Contacts: Double-pole double-throw (DPDT), snap-acting; rated for 10 A resistive, 6 FLA at 120 VAC.
 - .3 Adjustable Set Point: Range: -1 deg. C to 13 deg. C (30 deg. F to 55 deg. F) and set to 1.67 deg. C (35 deg. F).
 - .4 Regulatory: UL listed.
- .9 High Limit Electromechanical Thermostat:
 - .1 Type: Bimetallic sensing; manual reset upon activation.
 - .2 Mounting: Air stream.
 - .3 Electrical Contacts: Single-pole single-throw (SPST), normally closed, snap-acting; rated for 10 A resistive, 6 FLA at 120 VAC.
 - .4 Adjustable Set Point: Range: 38 deg. C to 66 deg. C (100 deg. F to 150 deg. F) and set to 57 deg. C (135 deg. F).
- .10 Electromechanical Thermostat:
 - .1 Wall Mount:
 - .1 Provide samples of covers to Part 1: Submittals, Samples.
 - .2 Low Voltage:
 - .1 Type: 24 VAC, bimetal-operated, mercury-switch; adjustable or fixed anticipation heater; vented ABS plastic concealed cover.
 - .2 Set Point: Range: 13 deg. C to 30 deg. C (55 deg. F to 85 deg. F); 1 deg. C (2 deg. F) maximum differential.
 - .3 Line Voltage:
 - .1 Type: Bimetal-actuated open contact, or bellow-actuated enclosed snap-switch type, or equivalent solid state type; anticipation heater; vented metal concealed cover.
 - .2 Electrical Contacts: Rated for 10 A resistive, 6 A FLA at 120 VAC.
 - .3 Set Point: Range: 13 deg. C to 30 deg. C (55 deg. F to 85 deg. F); 1 deg. C (2 deg. F) maximum differential.
 - .4 Regulatory: UL listed.
 - .11 Digital Thermostat:
 - .1 Digital thermostats shall be 7-day programmable digital type suited for the application.
 - .2 Standalone terminal units shall utilize a digital thermostat where shown on drawings.
 - .3 Digital thermostat shall have user selectable engineering units (F or C) and set point

- adjustment.
 - .4 Digital thermostat shall support automatic daylight savings time switchover.
 - .5 Digital thermostat shall support automatic and manual heat/cool changeover when applicable.
 - .6 Digital thermostat shall support temporary set point adjustment with automatic return to normal operation.
 - .7 Fan Coil thermostat shall be TACO VT7300C502. Thermostat shall provide all-in-one control for fan coil and associated heating and cooling pumps. Thermostat shall operate stand alone. Control shall be low voltage. Thermostat shall have a display and override button
- .12 Temperature Sensors:
- .1 General Requirements:
 - .1 Temperature sensors shall be of the resistance type, two-wire 1000 ohm nickel RTD, two-wire 1000 ohm platinum RTD or two-wire 10,000 ohm thermistor.
 - .2 Space Temperature Sensors:
 - .1 For installation throughout the facility unless otherwise noted.
 - .3 Space Temperature Sensors With Adjustable Set-Point, Override and Display:
 - .1 Key pad or slider for temperature set-point adjustment.
 - .2 LED display.
 - .3 Timed override request push button with LED status for activation of after-hours operation.
 - .4 For installation only where indicated on drawings, controls diagrams or sequences of operations.
 - .4 Covers for Wall Mount Sensors:
 - .1 Overrides: Exposed set point adjustment and override button.
 - .2 Communication Port: For communication between Portable Operator Terminals and ASC controllers.
 - .5 Averaging Temperature Sensors:
 - .1 Minimum 1.5 m (5 ft) of capillary per 1 sq m (10 sq ft) of duct cross-section.
 - .2 Provide multiple sensors where single averaging element is unable to be positioned to provide complete duct or plenum traverse.
 - .6 Outside Air Temperature Sensors:
 - .1 Outside air temperature sensors shall be designed to withstand the environmental conditions to which they will be exposed.
 - .2 The sensors shall be provided with a solar shield.
 - .3 Temperature transmitters shall be of NEMA 3R construction and rated for

ambient temperatures.

.7 Duct Temperature Sensors:

- .1 Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
- .2 Probe length shall be no less than 1/3 of the duct width or diameter.
- .3 For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

.8 Thermowells:

- .1 Brass or Type 316 stainless steel suitable for the application.
- .2 Heat transfer compound compatible with sensing element.

.13 Guards for Sensors and Thermostats:

- .1 Materials: Heavy gauge steel.

.14 Relative Humidity Sensors:

- .1 Sensors shall be calibrated to NIST standards.
- .2 Sensing Element:
 - .1 Type: Thin film capacitance.
- .3 Transmitter:
 - .1 Range: 0 to 100% RH.
 - .2 Signal: 4 to 20 mA or 0-10 VDC with span and zero adjustment.
- .4 Accuracy Rating: +/- 2 % of output reading.
- .5 Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure.
- .6 Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.

.15 Pressure Sensors:

- .1 General:
 - .1 Sensing Element:
 - .1 Type: Capacitance sensing.
 - .2 Materials: Suitable for continuous contact with measured medium.
 - .2 Transmitter:
 - .1 Range: Not to exceed two times the operating pressure.
 - .2 Signal: 4 to 20 mA or 0-10 VDC; with zero and span adjustment.
 - .3 Accuracy Rating: +/- 1.0 % of full scale.
 - .4 Response Time: Maximum 0.5 seconds.

- .3 Isolation Valve: Between process connection and sensor.
- .4 Capable of withstanding 100% overpressure without damage
- .2 Air Static Pressure Sensors:
 - .1 Sensing Element:
 - .1 Type: Capacitance sensing with pitot tube sensing tips screwed securely to duct.
- .16 Submersible Pressure Sensor:
 - .1 The sensor housing shall be made from high strength stainless steel or titanium for pressure ranges up to 100 PSI (689.5 kPa) and compatible with wide range of liquids.
 - .2 The sensor shall be vented through the cable to correct for barometric pressure changes.
 - .3 Sensor over range protection shall be two times rated pressure.
 - .4 Accuracy shall be +/- 0.25% of the full scale or better.
 - .5 Available control signals shall be 2-10 VDC or 4-20 mA.
- .17 AC Current Sensing Switches:
 - .1 Type: Self-powered solid-state with split-core.
 - .2 Electrical Contacts: Rated for 1 A resistive at 30 VAC/DC.
 - .3 Insulation Rating: 600 VAC.
 - .4 Adjustable trip point with LED status indicator.
- .18 AC Current Transducers:
 - .1 Type: Self-powered or loop-powered solid-state with split-core.
 - .2 Amperage Range: Motors: Factory calibrated to LRA; Switchgears: Factory calibrated to design load.
 - .3 Insulation Rating: 600 VAC.
 - .4 Signal: 4 to 20 mA or 0-10 VDC; internal zero and span adjustment.
 - .5 Accuracy Rating: +/- 2 % of full scale.
 - .6 Regulatory: UL listed or CSA approved.
- .19 CO2 Sensors:
 - .1 Sensor shall employ non-dispersive infrared technology (NDIR).
 - .2 Accuracy shall be +/- 75 ppm over 0-1500 ppm range.
 - .3 Response time shall be less than 1 minute.
 - .4 Sensor shall have field selectable 0-10 VDC and 4-20 mA outputs.
 - .5 Power voltage shall be 20-30 VDC/AC.
 - .6 Operating temperature range shall be 0°C to 50°C.

.7 The sensor shall be duct mounted.

.20 Gas Detection System:

.1 Gas Detection Controller:

- .1 Use: Centralized gas detection monitoring with real-time gas reading, selective alarm activation
- .2 Enclosure: NEMA 4X Polycarbonate – ABS
- .3 Power Requirement: 17-27 Vac, 24-38 Vdc, 500 mA
- .4 Network: Three Modbus channels for up to 96 transmitters, one wireless channel for up to 50 301W wireless transmitters and an optional BACnet/LON/IP output; Communication Line Up to 609 m (2000 ft.) per channel
- .5 Alarm Levels: 3 fully programmable alarm levels; Time Delays 0, 30 sec., 45 sec., 1-99 minutes before and after alarm
- .6 Outputs: 4 DPDT relays (alarms and/or fault) at 5 A, 30 Vdc or 250 Vac (resistive load); 65dBA buzzer
- .7 Display: 122 x 32 dot matrix LCD display
- .8 Operating Humidity Range: 0-95% RH, non-condensing
- .9 Operating Temperature Range: -20 to 50°C (-4 to 122°F)
- .10 Certifications: CAN/CSA C22.2 No 61010-1
- .11 Conforms to: ANSI/UL 61010-1; IEC 61010-1 Including Amendments A1:1992 + A2:1995 and National Deviations (Canada, US)
- .12 Make and Model: Vulcain 301C or equivalent.

.2 Wireless Gas Transmitter:

- .1 Use: Wall mounted, wireless gas detector transmitter used in conjunction with controller
- .2 Enclosure NEMA 4X Polycarbonate – ABS
- .3 Power Requirement: Battery operated with 2 years (minimum)
- .4 Sensing Technology: Electrochemical
- .5 Network: Wireless to the controller; Communication Protocol 2.4 Ghz - IEEE 802.15.4 - Secured 128-bit encryption
- .6 Visual Indicators: Two LEDs
- .7 Radius of Detection: 15.24 m (50 ft.)
- .8 Calibration: Not required for 2 years
- .9 Alarms: Centralized alarm management via controller
- .10 Conforms to: ANSI/UL 61010-1
- .11 Certified to: CAN/CSA C22.2 No. 61010-1 FCC Part 15 Subpart C(15.247) RSS 210 Section 6.2.2(o)

- .12 Make and Model: Vulcain 301W or equivalent.
- .3 Wired or Stand-Alone Gas Transmitter:
 - .1 Use: Wall mounted, wired gas detector transmitter used in conjunction with controller
 - .2 Power Requirement: 17-27 Vac, 24-38 Vdc, 250 mA
 - .3 Network: Modbus RS-485
 - .4 Display: 10-step LED or LCD
 - .5 Visual Indicators: Failure Indication = Yellow LED (Available in network configuration only); Normal Operation = Green LED
 - .6 Audible Alarm: 65 dBA at 3 ft. / 1 m
 - .7 Alarm Relay: Rating: 5A, 30Vdc or 250 Vac (resistive load)
 - .8 Optional Outputs: RS-485 Modbus, 4-20mA
 - .9 Sensing Technology: Toxic = Electrochemical; Combustibles = Catalytic; Oxygen = Diffusion fuel cell; Refrigerants = Solid-state
 - .10 Accuracy: Toxic, Combustibles, Oxygen = +/- 3%; Refrigerants = +/- 10%
 - .11 Detection Range: Carbon Monoxide = 0 - 250 ppm; Nitrogen Dioxide (NO₂) = 0- 10 ppm; Oxygen = 0-1 ppm; Combustibles = 0-100% LEL; Refrigerants R11, R12, R22 and R134a = 0-2000 ppm
 - .12 Certified to: CAN/CSA C22.2 No. 61010-1
 - .13 Conforms to: ANSI/UL 61010-1
 - .14 Make and Model: Vulcain 201T or equivalent.

2.6. WIRE AND CONDUIT

- .1 Conduit: Electrical metallic tubing EMT with compression type fittings in dry locations; cold rolled steel zinc coated or zinc coated rigid steel with threaded fittings in wet locations or where exposed to weather.
- .2 Outlet boxes: Dry locations: sheradized or galvanized drawn steel 100 mm (4 in.) square or octagon with suitable raised cover; Exposed to Weather: threaded hub cast aluminum boxes with gasket plate.
- .3 Junction boxes: Sized according to number, size and position of entering raceway; type: suitable for the environment.
- .4 Wire:
 - .1 Network: Per controls manufacturer recommendations.
 - .2 Analog Input, Output: Stranded 18 gauge copper twisted shielded.
 - .3 Binary Input, Output: 18 gauge, minimum insulation rating of 600 volts.
 - .4 Class 2: FT-6 without conduit in ceiling plenums; FT-4 in conduit for all other cases.

3. Execution

3.1. GENERAL WORKMANSHIP

- .1 Install all controllers, cabinets, control devices and power supplies in readily accessible locations providing adequate ambient conditions for its specified application and to the Canadian Electrical Code.
- .2 Install products to manufacturer's installation instructions.
- .3 Install parallel to building walls and floors unless indicated or specified or required by manufacturer's installation instructions.
- .4 Mechanical contractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.

3.2. COORDINATION

- .1 Submittals: To Part 1: General, Submittals.
- .2 Integrate and coordinate work under this section to controls and control devices provided or installed by others.
- .3 Each supplier of control product to configure, program, start-up and commission that product to satisfy requirements of Sequence of Operation regardless of where within contract documents product is described or specified.
- .4 Resolve compatibility issues between control product provided under this section and those provided under other sections or divisions of this specification.

3.3. WIRING AND CONDUIT

- .1 Wire shall be neatly tie wrapped to conduit mounted to the building structure but must be installed at right angles or parallel to the building. Loose wiring shall only be allowed over a distance of 1500 mm (5 ft.) but must not pass over lighting fixtures.
- .2 Wiring in Equipment Room, between floors, or between concrete walls shall be installed in conduit. Exposed wiring will not be accepted. Conduit shall be installed at right angles or parallel to the building walls.
- .3 Should it become necessary to splice field wiring it shall be soldered. If soldering is not possible, approved B type crimp connectors are an acceptable alternative. Wire nuts and Marr connections are not acceptable. Provide a 500 mm (20 in.) loop length at all splices.

- .4 Conceal conduit within finished shafts, ceilings, and walls as required. Install exposed conduit parallel with or at right angles to the building walls.
- .5 Plug or cap unused conduit openings and stubs with compatible fittings.
- .6 Route all conduit to clear beams, plates, footings and structural members except through column footings and grade beams.
- .7 Provide watertight seals at penetrations through outside foundation walls.
- .8 Support conduit 25 mm (1 in.) and smaller to the building with one-hole non-perforated malleable iron or steel pipe straps. Suspend conduits larger than 1 in. on pipe racks with split-ring hangers and rods.
- .9 Maintain caps on conduit openings throughout construction.
- .10 Where conduit is attached to vibrating or rotating equipment, install and anchor flexible metal conduit with a minimum length of 450 mm (18 in.) and a maximum length of 900 mm (36 in.) in such a manner that vibration and equipment noise will not be transmitted to the rigid conduit.
- .11 Where exposed to weather or in damp or wet locations, provide waterproof flexible conduit.
- .12 Fill conduit to maximum of 60% of its capacity. Provide a pull rope within the conduit when the installation is complete. Bend conduit to a radius of greater than 3 times the conduit diameter to a maximum of three 1/4 bends permitted between pull boxes.
- .13 Wire within cabinets shall be installed in a plastic tray with a cover. Terminate wires to field-removable, modular terminal strips.
- .14 All field sensors shall be provided with a flexible conduit connection minimum length of 450mm (18 in.) and an enclosure for the electrical connections.

3.4. POWER WIRING

- .1 Power for section 23 09 00.00 – Building Automation System (BAS) shall be provided under Electrical Division 16 at 120 VAC 60 Hz single phase and shall terminate in junction boxes installed where shown on electrical and mechanical drawings. Wiring and conduit from these boxes to control devices being electrically powered to be provided by section 23 09 00.00 – Building Automation System (BAS).
- .2 Where power for equipment is fed from MCC, 120 VAC power for Section 23 09 00.00 – Building Automation System (BAS) shall also be fed from the MCC from the 120 VAC section. Wiring and conduit from the MCC to control devices being electrically powered to be provided by section 23 09 00.00 – Building Automation System (BAS).

3.5. COMMUNICATION WIRING

- .1 Install communication wiring per controls manufacturer recommendations as to type of wire used and segment lengths.
- .2 Install communication wiring in conduit and raceways separated from other wiring.
- .3 Verify entire network's integrity following cable installation using appropriate tests for each cable.
- .4 Each run of communication wiring to be continuous length without splices.

3.6. OPERATOR INTERFACE

- .1 Operator Software:
 - .1 Security: Set up operators with independent user login name and password and assign access levels to Owner's requirements.
 - .2 Reports: Configure the following reports:
 - .1 List of objects and point object data that are in alarm state sorted by priority in descending order then by point object name in ascending order.
 - .2 List of disabled point objects sorted by point object name in ascending order.
 - .3 List of TOD Schedules: Indicate: objects assigned to the TOD Schedule, Occupied Mode times.
- .2 Graphics: Generate graphic representations for systems under Section 23 09 23.00 – Sequence Of Operation For BAS and as follows:
 - .1 Building elevation in three dimensions; indicate: floors and mechanical rooms.
 - .2 Floor plans: Indicate: Equipment rooms; point object data for temperature, humidity and pressure. Directly access graphic representation for terminal systems.
 - .3 Equipment Rooms: Indicate locations for systems.
 - .4 Systems: Indicate: Equipment, service connections, point object data, set points, reset schedules. Highlight point objects under operator command.
 - .5 Graphic representations link to and display graphic representations for associated systems.

3.7. CABINETS

- .1 Install rigidly to wall or to an independent frame installed to the floor slab. Installation to duct, equipment and locations subject to vibration is not accepted.
- .2 Cabinets for ASC controllers: Install to terminal equipment. Installation to duct, equipment and

locations subject to vibration that could affect controller operation or calibration of control device is not accepted.

- .3 Coordinate cabinet locations with other trades and general contractor.

3.8. CONTROL DEVICES

- .1 Provide or furnish control devices as indicated on the drawings and to the requirements of this Section and to execute sequence of operation under Section 23 09 23.00 – SEQUENCE OF OPERATION FOR BAS.
- .2 Motor Operated Dampers:
 - .1 Furnish motor operated dampers for installation under Section 23 31 13.00 – DUCTWORK AND SPECIALTIES. Provide supervision on site during installation.
 - .2 Install in areas maintained above freezing.
- .3 Actuators for Dampers, Electronic:
 - .1 Mounting: Direct coupled to drive shaft or jackshaft using a V bolt design.
- .4 Control Valves:
 - .1 Furnish control valves for installation under Section 23 21 13.23 – PIPE, VALVES AND FITTINGS (EXCEPT PLUMBING). Provide supervision on site during installation.
- .5 Actuators for Control Valves, Electronic:
 - .1 Factory install or field install actuator to valve body.
- .6 Low Limit Electromechanical Thermostat:
 - .1 Install hardwire interlocked to supply fan starter for respective system.
 - .2 Provide according to Section 23 09 23.00 – SEQUENCE OF OPERATION FOR BAS.
 - .3 Shut down the fan when duct temperature is equal to or less than 1.67 deg. C (35 deg. F).
 - .4 Install to adequately cover potential areas of low level stratification. Provide one low-limit thermostat for each 2.8 sq M (25 sq ft) of duct cross section. Mount sensing element on plastic clips.
- .7 High Limit Electromechanical Thermostat:
 - .1 Install hardwire interlocked to fan starters for respective system.
 - .2 Shut down the fans when duct temperature is equal to or greater than 51.7 deg. C (125 deg. F).

.3 Provide one high-limit thermostat for each 3.7 sq M (40 sq ft) of duct cross section.

.8 Electromechanical Thermostats and Temperature Sensors:

.1 Furnish sensing wells for installation under Section 23 21 13.23 – PIPE, VALVES AND FITTINGS (EXCEPT PLUMBING). Provide supervision on site during installation.

.2 Samples: Provide for wall mount type to Part 1: Submittals, Samples.

.3 Wall Mount Type:

.1 Cover Colour: White.

.2 Install to furred-in columns and permanent walls on concealed junction boxes supported by wall framing or surface mount 1.2 m (4 ft) above finished floor. Installation to mobile and temporary partitions is not acceptable.

.3 Installation to exposed architectural concrete columns and walls is not acceptable, unless otherwise indicated or specified. For installation to concrete, set conduit in place before pouring of concrete.

.4 Single Point Type, Duct:

.1 Provide sufficient contact with process fluid to measure average conditions.

.2 Apply pipe sealing compound to plug thread.

.5 Single Point Type, Pipe:

.1 Provide sufficient contact with process fluid to measure average conditions.

.2 Install with heat conducting fluid in wells.

.6 Outdoor Type:

.1 Install to north side of building away from sources of heat such as lamps and exhaust vents; to greater than 1500 mm (5 ft) above horizontal surfaces.

.2 Where indicated or specified for installation in outside air intake, locate so as not to be affected by exhaust air flow or reverse flow.

.3 Provide solar shield. Install shield to open downward.

.4 Seal interior of conduit at penetration through exterior wall.

.7 Guards for Thermostats and Temperature Sensors:

.1 Provide for wall mount sensors and thermostats where indicated on the drawings.

.2 Samples: Provide to Part 1: Submittals, Samples.

.8 Air Static Pressure Sensors:

.1 Duct Mount: Pipe the high-pressure tap to the duct using a pitot tube.

.2 Building Static: Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building and install with a shielded static air probe to reduce pressure fluctuations caused by wind.

- .3 The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
- .9 Wet/Wet Differential Pressure Sensors:
 - .1 Differential pressure sensors shall be supplied with tee fittings and shut-off valves in the high and low sensing pick-up lines.
- .10 Relative Humidity Sensors:
 - .1 Install to requirements for Electric Thermostats and Temperature Sensors.
- .11 AC Current Sensors and Transducers:
 - .1 Install in motor starter cabinet.
- .12 CO Sensors:
 - .1 Mount the sensor 4-6 feet from the floor.
- .13 Air Flow Sensors, Fan Bell Mouth:
 - .1 Coordinate installation of air flow sensors to inlet of fans with fan manufacturer.
- .14 Air Flow Sensors, Duct Mount:
 - .1 Furnish duct mount air flow sensors for installation under Section 23 31 13.00 – DUCTWORK AND SPECIALTIES. Provide supervision on site during installation.

3.9. IDENTIFICATION

- .1 All wires shall be tagged at both ends. The tagging shall identify the device it is connected to. Use of the point object name is acceptable.
- .2 All wires passing through a junction box shall be tagged with the device identity or its termination point.
- .3 The junction boxes shall be tagged "BAS" with a sequential number suffix.
- .4 Label wires, control devices, controllers.

3.10. TESTING AND COMMISSIONING

- .1 Test and commission the BAS prior to the Demonstration and Acceptance Test.

-
- .2 Prepare test forms which shall identify each test. The forms shall be sub-divided into points, controllers, programs, loops, networks and graphics.
 - .3 Device tests shall identify and confirm successful completion of the following:
 - .1 Device installation.
 - .2 Device identification.
 - .3 Device calibration.
 - .4 Device operation.
 - .5 Wiring to device, connection details and wire type.
 - .6 Validation of the device signal at the controller.
 - .4 Controller tests shall identify and confirm successful completion of the following:
 - .1 Controller installation.
 - .2 Power source and grounding.
 - .3 Make, model and serial number, software revisions.
 - .5 Software tests shall identify and confirm successful completion of the following:
 - .1 Custom application programs.
 - .2 Alarm reporting.
 - .3 Trending and reports.
 - .4 Energy management programs.
 - .6 Loop tuning tests shall identify and confirm successful completion of the following:
 - .1 Loop input signal.
 - .2 Loop output signal.
 - .3 Set point adjustment.
 - .4 Device response.
 - .5 Control response.
 - .7 Network communication tests shall identify and confirm successful completion of the following:
 - .1 Primary network communication function.
 - .2 Secondary network communication function.
 - .3 Alarm reporting function.
 - .4 Operator communication.
 - .8 Dynamic graphics tests shall identify and confirm successful completion of the following:
 - .1 All graphics.

- .2 All point objects per graphic.
- .3 All set-points per graphic.

3.11. DEMONSTRATION

- .1 When all tests have been completed and the documentation completed, request a meeting with the Consultant and Owner. Provide at this meeting a demonstration that all systems on the BAS are operating. At the successful conclusion of this demonstration the Consultant will allow the Acceptance Test to begin.
- .2 At the discretion of the Consultant and Owner, demonstrate up to 10% of the tests described in Part 3: Execution, Testing and Commissioning and witnessed by the Consultant and Owner. Should any test fail then the BAS Contractor shall retest the failed components or functionality.

3.12. ACCEPTANCE TEST

- .1 When Testing and Commissioning and the Demonstration have been completed satisfactorily the Consultant will give approval for commencement of the Acceptance Test.
- .2 Notify the Owner in writing 2 weeks prior to the testing date.
- .3 Furnish a new operator's log book to building operators.
- .4 The Acceptance Test period shall be 21 days. Visit the site each morning, Monday to Friday, to review the BAS operation and the building operators log book which contains records of all problems experienced by the building operators, the point object name and value and time and date of failure, and time of return to service. During the first 14 days of the acceptance test, any operational failures due to malfunction of wiring, controllers or Operator Interfaces, shall designate a restart to testing for 21 days. Any failure of control devices shall be corrected and the acceptance test shall continue from the date the failure has been corrected. During the last 7 days of testing, no failures of any kind will be accepted, or the last 7 days shall be repeated.
- .5 The BAS shall not be accepted or considered substantially complete until the Acceptance Test is successfully completed.
- .6 At the successful completion of the Acceptance Test, provide a certificate of completion.

3.13. INSTRUCTION AND TRAINING

- .1 Provide three days of instruction during the BAS installation. This instruction shall include: identification of devices, power sources, conduit and wire installation, the operation of controlled devices and how they interface with the mechanical systems.
- .2 Provide an additional five days of instruction that shall cover the operation and maintenance of the BAS systems. The instruction shall be conducted in the building and videotaped by the Owner. Submit training course outline for review by the Consultant before completion of the BAS and before instruction period commences. Instruction shall include:
 - .1 Operation and maintenance of Operator Interfaces.
 - .2 Operation and maintenance of controllers.
 - .3 Custom Application Programming software.
 - .4 Point objects addressing and commanding.
 - .5 Custom reporting.
 - .6 Creating and modifying graphics.
 - .7 Data base modification, deletion and back-up and restore operations.
 - .8 System malfunction diagnostics and maintenance.
 - .9 Control devices, operation and maintenance.
- .3 Provide an additional three days of training that may be scheduled up to six months after BAS Acceptance. The Owner will advise the BAS Contractor of the training content required.
- .4 One day shall be 7.5 working hours excluding one hour lunch break.

END OF SECTION

1. General

1.1 RELATED WORK

- .1 Testing, Adjusting and Balancing of Electrical Equipment and Systems Section 26 01 26
- .2 Electrical Equipment and Systems Demonstration and Instruction Section 25 05 83

1.2 COORDINATION

- .1 Coordinates starting of electrical equipment and systems with testing, adjusting and balancing, and demonstration and instruction of:
 - .1 Electrical equipment and systems specified in Division 26.
 - .2 Mechanical equipment and systems specified in Division 23.
 - .3 Other equipment and systems specified in other Divisions.
- .2 Where any equipment or system requires testing, adjusting or balancing prior to starting, ensure that such work has been completed prior to starting of electrical equipment and systems.

2. Products

- .1 Not Used

3. Execution

3.1 ENERGIZING MAIN ELECTRICAL SYSTEM

- .1 Prior to energizing main electrical system:
 - .1 Verify supply authority voltage and phase rotation.
 - .2 Close and open all devices to ensure proper mechanical operation.

3.2 STARTING MOTORS

- .1 Prior to starting motors:
 - .1 Verify phase rotation at motor control centres.
 - .2 Confirm motor nameplate data with motor starter heater overloads.

3.3 ENERGIZING EQUIPMENT

- .1 Prior to energizing equipment provided under other Sections and equipment provided by the Owner.
- .2 Confirm equipment nameplate data with characteristics of power supply.

END OF SECTION

1. General

1.1 INTENT

- .1 Except where otherwise specified, arrange and pay for testing, adjusting, balancing and related requirements specified herein.
- .2 If test results do not conform with applicable requirements, repair, replace, adjust or balance equipment and systems. Repeat testing as necessary until acceptable results are achieved.
- .3 Provide all labour, materials, instruments and equipment necessary to perform the tests specified.
- .4 All tests shall be witnessed by persons designated by the Owner, who shall also sign the test documentation.
- .5 Submit procedures proposed in writing for approval two (2) weeks prior to test.

1.2 RELATED REQUIREMENTS

- .1 Electrical Operation and Maintenance Data Section 26 05 01
- .2 Starting of Electrical Systems and Equipment Section 26 01 25

1.3 MANUFACTURER'S PRODUCTION TEST RECORDS

- .1 If requested, submit copies of production test records for production tests required by EEMAC and CSA standards for manufactured electrical equipment.

1.4 SITE TESTING REPORTS

- .1 Log and tabulate test results on appropriate test report forms.
- .2 Submit forms to Owner for approval prior to use.
- .3 Submit completed test report forms as specified, immediately after tests are performed. Final test report to be included in electrical O&M Manuals.

1.5 REFERENCE DOCUMENTS

- .1 Perform tests in accordance with:
 - .1 The Contract Documents
 - .2 Requirements of authorities having jurisdiction
 - .3 Manufacturer's published instructions
 - .4 Applicable CSA, IEEE, IPCEA, EEMAC and ASTM standards
- .2 If requirements of any of the foregoing conflict, notify A/E before proceeding with test and obtain clarification.

1.6 MANUFACTURER'S SITE SERVICES

- .1 Arrange and pay for the site services of appropriately qualified manufacturer's representatives where site testing, adjusting, or balancing of electrical equipment or systems' performed by Manufacturer's representatives is:

- .1 Specified, or
- .2 Otherwise required to ensure that electrical equipment and systems are operational in full compliance with the Contract Documents

1.7 SEQUENCING AND SCHEDULING

- .1 Except where otherwise specified, perform all testing, adjusting, balancing and related requirements specified herein prior to Interim Acceptance of the Work.
- .2 Perform voltage testing and adjusting after user occupancy or utilization of facility.

2. Products

2.1 TEST EQUIPMENT

- .1 Provide all equipment and tools necessary to perform testing, adjusting and balancing specified herein and as otherwise required.

3. Execution

3.2 TESTING OF WIRING AND WIRING DEVICES

- .1 All power and control wiring shall be tested for insulation resistance value with a 1000 volt megger. Resistance values shall be as recommended by cable manufacturer. Test results shall be properly tabulated, signed, dated and submitted with maintenance manuals.
- .2 Test service grounding conductors for ground resistance.
- .3 Test all wiring devices for correct operation.
- .4 Test all receptacles for proper polarity and circuitry.

3.3 LOAD BALANCE TESTING

- .1 Perform load tests when as many loads as possible, prior to Interim Acceptance of the Work, are operable.
- .2 Turn on all possible loads.
- .3 Test load balance on all feeders at distribution centres, motor control centre and panelboards.
- .4 If load balance exceeds 15%, reconnect circuits to balance loads, update as built.

3.4 VOLTAGE TESTING AND ADJUSTING

- .1 Test voltage at all panelboards.
- .2 Test voltage at motor control centre.
- .3 Adjust transformer tap settings to compensate for under-voltage or over-voltage conditions, if directed to do so by A/E.
- .4 Confirm phase rotation and colour coding of conductors at the main switchboard, all panelboards and motor control centres.

END OF SECTION

1. General

1.1 WORK INCLUDED

- .1 Complete and operational electrical system as required by the drawings and as herein specified.

1.2 RELATED WORK

- | | | |
|----|----------------------|------------------|
| .1 | General Requirements | Section 01 00 00 |
| .2 | Site Work | Section 31 00 00 |
| .3 | Concrete | Section 03 00 00 |
| .4 | Doors and Windows | Section 08 00 00 |
| .5 | Finishes | Section 09 00 00 |
| .6 | Specialties | Section 10 00 00 |
| .7 | Equipment | Section 11 00 00 |
| .8 | Mechanical | Section 23 00 00 |

1.3 DRAWINGS AND SPECIFICATIONS

- .1 The General Conditions, Supplementary Conditions and Division 1 are a part of this specification and shall apply to this Division.
- .2 The intent of the drawings and specifications is to include all labour, products and services necessary for complete work, tested and ready for operation.
- .3 Mention herein or indication on the drawings, of articles, materials, operations or methods requires that all such items shall be supplied in the quality and quantity required, and that the operations shall be performed according to the methods prescribed, complete with all necessary labour and incidentals.
- .4 These specifications and the drawings and specifications of all other divisions shall be considered as an integral part of the accompanying drawings. Any item or subject omitted from either the specifications or the drawings but which is mentioned or reasonably specified in and by the others, shall be considered as properly and sufficiently specified and shall be provided. Also refer to 3.2 (this section) coordination with other divisions.
- .5 Provide all minor items and work not shown or specified but which are reasonably necessary to complete the Work.
- .6 If discrepancies or omissions in the drawings or specifications are found, or if intent or meaning is not clear, advise the Owner for clarification before submitting tender.
- .7 Responsibility to determine which Division provides various products and work rests with the Contractor. Additional compensation will not be considered because of differences in interpretation of specifications.

1.4 QUALITY ASSURANCES

- .1 Codes, Rules, Permits & Fees
 - .1 Comply with all laws, ordinances, rules, regulations, codes and orders of all authorities having jurisdiction relating to this work.
 - .2 Comply with all rules of the Electrical Protection Act of BC, CSA Standards and Canadian Underwriters Laboratories and the applicable building codes, whether specifically shown on drawings or not.
 - .3 Quality of work specified and/or shown on the drawings shall not be reduced by the foregoing requirements.
 - .4 Immediately after award of contract and prior to installation, verify location, arrangement and point of attachment for service and service entrance equipment with supply authority and inspection departments. Failure to do so will render this Division responsible for any corrections necessary without additional compensation.
 - .5 Give all required notices, submit drawings, obtain all permits, licenses and certificates and pay all fees required for this work.
 - .6 Furnish a Certificate of Final Inspection and approvals from inspection authority to the Owner.
- .2 Standards of Workmanship
 - .1 Execute all work in a competent manner and to present an acceptable appearance when completed.
 - .2 Employ a competent supervisor and all necessary licensed tradesmen to complete the Work in the required time.
 - .3 Arrange and install products to fit properly into designated building spaces.
 - .4 Unless otherwise specified or shown, install products in accordance with recommendations and ratings of manufacturers.

1.5 SUBMITTALS

- .1 Refer to architectural specifications.

1.6 RECORD DRAWINGS

- .1 Maintain on site a complete set of as-built drawings as listed in General Conditions and as follows. Before commencing work, obtain a set of white prints of all drawings pertinent to the work. Keep record drawings on site and continuously update to accurately record in coloured pencil all items such as change orders, alterations or Facility's, runs of conduit, numbers and location of outlets, motors, panels and luminaires that may occur during the progress of the work.
- .2 Before substantial performance is granted to this Contractor, neatly transpose this information onto a set of full size white paper set of drawings in red and coloured ink. All conduit runs and junction boxes larger than 150 mm square must be shown on the Record Drawings, complete with size and wire count. Provide one (1) complete printed set and colour scanned version.
- .3 Before requesting final certificate, make any necessary final corrections, sign each print as a certification of accuracy and deliver all sets to the Owner.

1.7 OPERATIONS AND MAINTENANCE MANUALS

- .1 Before requesting final certificates, submit two complete sets of the operating/maintenance manuals, as specified in the General Conditions. Refer to Section 01781.
- .2 Binders: Extension type catalogue binders bound with heavy fabric, hot stamped in gold lettering front and spine, sized for 216 mm (8 ½") x 279 mm (11") paper. Binders must not exceed 76 mm (3") thick or be more than 2/3 full. Binder colour to be yellow with the lettering on the front spine to read:
 - Project Title
 - Date Submitted
 - Project Location
 - Manual Title
 - Volume Number
 - Project Number
- .3 Each manual shall contain:
 - Table of contents. Arrange contents sequentially by systems under section numbers. Label tabs of dividers between each to match section numbers in table of contents.
 - Tabs are to be celluloid covered fastened to hard paper dividing sheets.
 - List the electrical engineering firm and electrical contractor with names, addresses and telephone numbers of contacts.
 - Systems Descriptions. A brief synopsis of each system typed and inserted at the beginning of each section. Include sketches and diagrams where appropriate.
 - Descriptive and technical data to follow the general layout of the specifications.
 - Maintenance and operating instructions for all electrical equipment and controls. (These operating instructions need not be manufacturer's data but may be typewritten instructions in simple language to guide the Owner in the proper operation and maintenance of his installation.)
 - Lubricating and servicing intervals recommended.
 - A copy of all wiring diagrams complete with wire coding.
 - List of spare parts of all electrical equipment complete with names, addresses, and telephone numbers of sales, service representatives and suppliers.
 - Copy of test data
 - A motor list showing each motor number, name, horsepower, nameplate, current rating, heater size and type, and current being drawn, on the form specified in Section 26 05 82.
 - Include type and accuracy of instruments used.
 - Copy of final inspection certificate.
 - Set of final reviewed Shop Drawings.
- .4 Electrical Operation and Maintenance Manuals are to be organized.

1.8 PRODUCT HANDLING

- .1 Use all means necessary to protect the products of this Division before, during and after installation and to protect products and installed work of all other trades.
- .2 Immediately make good any damage by repair or replacement at no additional cost to the Owner and to the approval of the Owner.
- .3 Remove advertising labels from fixtures, conduit, panelboards, etc. Do not remove identification or CSA labels.

- .4 Remove dirt, rubbish, grease, etc. resulting from this work from all surfaces.

1.9 ALTERNATE AND SEPARATE PRICES

- .1 In accordance with the Instructions to Bidders, state on the Tender Form in the space provided, the amount to be deducted from the base bid tender amount for the use and installation of equipment as an alternate to those specified and the requested separate prices.

1.10 GUARANTEE

- .1 Furnish a written guarantee to the Owner prior to final contract payment, which will be in effect for one year from the date of final acceptance of the complete work. Replace or repair at no cost to the Owner any defective material or workmanship except where, in the opinion of the Owner, such defects are due to the misuse or neglect by the Owner.
- .2 This general guarantee shall not act as a waiver of any specified or special equipment guarantees which cover a greater length of time.

1.11 PROGRESS CLAIMS

- .1 Within thirty (30) days after award of contract, a breakdown of material and equipment items including labour and expense components shall be compiled on the Owner format. Subsequent requests for payment shall be documented accordingly.

1.12 WORK SCHEDULE

- .1 Install work to facilitate installation and servicing of indicated future work.
- .2 Work shall be done in phases as described in Architectural.
- .3 Layout electrical work to allow for phasing of work. Refer to architectural for breakdown of phases and for construction schedule regarding phasing.

1.13 FOR ENGINEERS SERVICES

- .1 Division 26 to include, for all costs to provide construction related engineering services specified herein.
- .2 These services include, but are not limited to:
 - .1 All costs for additional engineering services during construction as a result of the following:
 - .1 Re-inspection due to incomplete or defective work.
 - .2 Contractor caused delays during normal testing and inspection procedures.

2. Products

2.1 SELECTED PRODUCTS AND EQUIVALENTS

- .1 Products and materials provided shall be new and free from all defects. Related materials shall be of the same manufacturer throughout the project.

- .2 Products and materials called for on the drawings or in the specifications by trade names, manufacturer's name and catalogue reference are those which shall be used as the basis for the Tender.
- .3 The design has been based on the use of the first named product.

2.2 ALTERNATIVE PRODUCTS

- .1 Alternative products and materials to those specified shall only be considered if they are shown in the Tender as a material variation with an appropriate price adjustment. The Owner reserves the right to accept or reject any alternative without explanation.
- .2 Submission shall provide sufficient information to enable the Owner to determine acceptability of such products. Submission to be submitted seven (7) days before close of tender.
- .3 Provide complete information on required revisions to other work and products to accommodate each alternate product, and the amount of Facility or reduction from tender amount, including required revisions, for each alternate product.
- .4 Assume full responsibility for ensuring that when providing alternative products or materials, all space, weight, connections, power and wiring requirements etc. are considered. Any costs incurred for additional components, changes to services, structural or space requirements, layouts and plans, etc. that may be necessary will be borne by the contractor.
- .5 Unless a proposal for an alternative product is submitted in this manner and later accepted, provide the product specified.
- .6 Materials or equipment rejected by the Owner shall be immediately removed from the project and suitable materials shall be provided.
- .7 Prior approval to submit a proposal for an alternative product with the Tender is not required.

2.3 REVIEW OF PRODUCTS

- .1 Immediately after notification of award of contract, review with the Owner a list of products proposed, including any alternatives submitted with tender.
- .2 After agreement on product list, no subsequent changes will be permitted except as specified hereafter.

2.4 SUBSTITUTION OF PRODUCTS AFTER CONTRACT AWARD

- .1 After acceptance of the list of products, no substitution of any item will be permitted unless the approved item cannot be delivered in time to comply with the work schedule.
- .2 To receive acceptance, proposed substitutes must equal or exceed the quality, finish and performance of those specified and/or shown, and must not exceed the space requirements allotted on the drawings.
- .3 Provide to the Owner documentary proof of equality, difference in price (if any) and delivery dates, in the form of certified quotations from suppliers of both specified items and proposed substitutions.
- .4 Include costs for any required revisions to other structures and products to accommodate such substitutions.

2.5 QUALITY OF PRODUCTS

- .1 All products provided shall be CSA Approved, Canadian Underwriters' Laboratory approved where applicable, and new, unless otherwise specified.
- .2 If products specified are not CSA approved, obtain approval of provincial regulatory authority. Pay all applicable charges levied and make all modifications required for approval.
- .3 Products provided, if not specified, shall be new, of a quality best suited to the purpose required and their use subject to approval by the Owner.

2.6 UNIFORMITY OF MANUFACTURE

- .1 Unless otherwise specifically called for in the Specifications, uniformity of manufacture shall be maintained for similar products throughout the work.

2.7 PRODUCT FINISHES

- .1 Finish all cabinets, panelboards, switchboards, equipment cabinets, cable trays, etc. in ANSI 61 grey enamel unless otherwise specified.
- .2 Apply primer on all items which are to be finished on the job.
- .3 Touch up all damaged painted finishes with matching lacquer, or, if required by the Owner, completely repaint damaged surface.

2.8 USE OF PRODUCTS DURING CONSTRUCTION

- .1 Any equipment used for temporary or construction purposes shall be approved by the Construction Manager and in accordance with the General Conditions, "Use of Premises." Clean and restore to "as new" condition all equipment prior to the time of substantial completion.
- .2 The warranty period shall not begin until the date of substantial performance of the work.

3. Execution

3.1 SITE EXAMINATION

- .1 Examine the site of work and become familiar with all features and characteristics affecting this work before submitting tender.
- .2 No additional compensation will be given for extra work due to existing conditions which such examination should have disclosed.
- .3 Report to the Owner any unsatisfactory conditions which may adversely affect the proper completion of this work.

3.2 COORDINATION WITH OTHER DIVISIONS

- .1 Examine the drawings and specifications of all divisions and become fully familiar with their work. Before commencing work, obtain a ruling from the Owner if any conflict exists, otherwise no additional compensation will be made for any necessary adjustments. Also refer to item 1.3.4 this section.
- .2 Fully understand the functions of the systems specified and have no doubts with regard to the extent of the Contract.

- .3 Coordinate with all Divisions installing equipment and services, and ensure that there are no conflicts.
- .4 Install anchors, bolts, pipe sleeves, hanger inserts, etc. in ample time to prevent delays.
- .5 Lay out the work and equipment with due regard to architectural, structural and mechanical features. Architectural and structural drawings take precedence over electrical drawings regarding locations of walls, doors and equipment.
- .6 Do not cut structural members without approval of the Owner.

3.3 LOCATION OF OUTLETS AND LUMINAIRES

- .1 Electrical drawings are, unless otherwise indicated, drawn to scale and approximate distances and dimensions may be obtained by scaling. Figured dimensions shall govern over scaled dimensions. Where exact dimensions and details are required, refer to Architectural and Structural drawings.
- .2 Outlet and equipment locations shown on the drawings are approximate. Locations may be revised up to 3 meters to suit construction and equipment arrangements without additional cost to the Owner, provided that installation has not been completed.
- .3 Maintain luminaire locations wherever possible. Notify the Owner of conflicts with other services.
- .4 Unless otherwise specified or shown, install products in accordance with recommendations and ratings of manufacturers.

3.4 SEPARATION OF SERVICES

- .1 Maintain separation between electrical wiring system and building piping, ductwork, etc. so that wiring system is isolated (except at approved connections to such systems) to prevent galvanic corrosion.
- .2 In particular, contact between dissimilar metals, such as copper and aluminum, in damp or wet locations is not permitted.
- .3 Do not support wiring from pipes, ductwork, etc. Hangers for suspended ceilings may be used for the support of wiring only when approval is obtained from the Owner and the ceiling installer, and approved clips or hangers are used.

3.5 IDENTIFICATION

- .1 Clearly mark all exposed conduit, junction boxes, etc., to indicate the nature of service.
- .2 Provide neatly typed circuit directories in panelboards to indicate the area or equipment controlled by each branch circuit.
- .3 All conductors shall be identifiable by coloured insulation and permanent markers at every terminal and accessible points throughout its entire run.
- .4 All exposed feeder conduits for all systems and all control conduits shall be clearly identified at all pull box locations.

- .5 Conductor s:
- Equipment Grounding - Green
- Neutral Conductor - White
- | <u>120/208 Volt System</u> | <u>347/600 Volt System</u> |
|----------------------------|----------------------------|
| Phase A - Red | Phase A - Orange |
| Phase B - Black | Phase B - Brown |
| Phase C - Blue | Phase C - Yellow |
- .6 Low Voltage Wiring: per manufacturer's standard, i.e. PDM low voltage relay switching system.
- .7 All colours referred to in the above paragraphs shall be as follows:
- | | |
|--------|---|
| Grey | Canadian General Standards Board #501-107 Grey |
| Green | Canadian General Standards Board #503-211 Apple Green |
| Blue | Canadian General Standards Board #202-101 Dark Blue |
| Red | Canadian General Standards Board #509-102 Red |
| Bronze | Canadian General Standards Board #514-101 Bronze |
| Brown | Canadian General Standards Board #504-104 Brown |
- .8 Submit paint chips for approval for all colours referred to in the above paragraphs prior to manufacture of equipment.
- .9 Pull Boxes and Conduit:
- Conduit as indicated previously and one conduit entering or leaving a pull box shall be identified as follows:
- 120/208V: Red background with black letters "120/208V"
Telephone System: Green background with black letter "T"
Low Voltage Control Circuits: Black background with black letters "TV"
Television Distribution: Green background with black letters "TV"
- Use Brady self-sticking identification tape, or approved equal. The use of "Dymo" tape identification is not acceptable.

3.6 WIRING TO EQUIPMENT SUPPLIED BY OTHERS

- .1 Equipment supplied by the Owner or under other Division will be moved to the installation site by others. However, the electrical connection to the equipment shall be done by this Division.
- .2 It is the responsibility of this Division to ensure that all wiring, connectors, branch circuit breakers, etc. are sized to and match the equipment provided.

3.7 TESTING

- .1 Refer To Section 26 01 26

3.8 SINGLE LINE DIAGRAM

- .1 Provide and mount a framed as-built single line diagram at the main electrical equipment. Use a clear plexiglass cover. The diagram shall be 914 mm x 600 mm minimum, with all lettering Leroyed.

3.9 INSTRUCTIONS TO OWNER'S PERSONNEL

- .1 Refer To Section 26 05 83

3.10 ACCESS PANELS

- .1 Where electrical equipment, junction boxes, remote ballasts or the like are concealed, access panels shall be supplied. Panels shall be of adequate size for servicing of the electrical work and complete with necessary frames and hinged doors held closed with captive fasteners. Coordinate type and size of panels with the Owner.
- .2 In removable ceiling areas, provide markers on ceiling tile to locate equipment requiring access. Markers shall be of a type approved by the Owner.

3.11 MOUNTING HEIGHTS

- .1 Unless a conflict exists, use the following as mounting heights from finished floors:

Data Receptacles	787 mm to centre of outlet
Data Outlets	787 mm to centre of outlet
Receptacles in Mechanical Rooms	1,070 mm to centre
Receptacles & Telephone Outlets	1070 mm to centre
Light Switches	1,220 mm to centre
Clocks	2,300 mm
Panels and Starters to top of cover	1,870 mm
End of Line Resistors (maximum)	1525 mm (maximum 1800mm)
Receptacles & Telephone Outlets above counters	150 mm above countertop or 150 mm above splash bar
Emergency Lighting Remote Heads	2,300 mm or 2,800 mm in high ceiling areas or as indicated on drawings
Power Receptacle supporting data outlet	460 mm to bottom of outlets
Classroom Telephones	1500 mm to centre

3.12 SEALING OF WALLS AND FLOOR OPENINGS

- .1 All conduit and cable entries through outside walls of buildings, through partition walls separating electrical rooms from other areas, through fire separations, and through floors above grade shall be sealed to prevent passage of moisture, dust, gasses, flame, or to maintain pressurization.
- .2 Openings shall be sealed when all wiring entries shown on the drawings have been completed.
- .3 Sealing material shall be fire resistant and shall not contain any compounds which will chemically affect the wiring jacket or insulating material. Cable penetrations through fire separations to be sealed in accordance with Section 26 05 01.

3.13 FIRE PROTECTION OF ELECTRICAL CONDUCTORS

- .1 Fire rated access panels shall be provided in the enclosures where required.

- .2 The fire rated enclosures required by this Division shall, unless otherwise noted, be by this Division and shall be in accordance with the sections of the specification detailing the fire rated enclosures requirements.
- .3 Advise the extent of the fire rated enclosures required and supply all information and details as to size and locations within thirty days after the award of the contract.
- .4 Failure to comply with the above requirements shall be remedied at this Division's expense.
- .5 Where fire rated cables that comply with the requirements of the Authorities having jurisdiction are provided, it shall not be required that they be installed in fire rated enclosures.

3.14 HOUSEKEEPING PADS

- .1 All floor mounted electrical equipment installed by this Division shall be mounted on concrete housekeeping pads which shall, unless otherwise noted, be by this Division.
- .2 Advise the extent of the housekeeping pads required and supply all information and details as to size and locations within thirty days after the award of the Contract.
- .3 Failure to comply with the above requirements shall be remedied at this Division's expense.

3.15 SLEEVES

- .1 Provide sleeves of galvanized steel pipe with machine cut ends of ample size to accommodate conduits passing through walls, partitions, ceilings, floors, etc.
- .2 For wall, partitions and ceilings the ends shall be flush with the finish on both sides but for floors they shall extend 4" above finished floor level.
- .3 The space between the sleeve and the conduit shall be filled with Dow Corning silicone RTV foam for fire stop and caulked around the top and bottom with approved permanently resilient, non-flammable and weatherproof silicone base compound and ensure that the seal is compatible with the floor and ceiling finishes.
- .4 Locate and position sleeves exactly prior to construction of walls, floors.
- .5 Failure to comply with the above requirements shall be remedied at this Division's expense.

3.16 PRICEBREAKDOWN

- .1 The successful bidder shall, following award of contract, give a breakdown of the tender price as follows:
 - .1 Electrical distribution equipment and feeders.
 - .2 Emergency distribution system including emergency and exit lights.
 - .3 Lighting, branch circuit wiring and controls.
 - .4 Mechanical equipment, power and control wiring.
 - .5 Miscellaneous power and branch circuit wiring (indicate items included).
 - .6 Telephone/Data raceway and wiring system.
 - .7 Intercommunication/Security Conduit Systems

3.17 EQUIPMENT STORAGE AND PROTECTIONS

- .1 Deliver equipment in original wrapping or containers, with manufacturer's label and seals intact.
- .2 Handle and store equipment in accordance with manufacturer's recommendations and prevent damage, inclusion of foreign matter, rusting, staining and defects which will affect performance and appearance.
- .3 Equipment containing components such as open bussing, contacts and solid state devices to be adequately and continuously protected in an enclosed, dry and dust-free environment while in transit, during installation and until completion of the Contract. The Owner may not accept repair of defective equipment if the above is not observed.

3.18 WORKMANSHIP

- .1 Workmanship to be of a high standard throughout.
- .2 Exposed conduit runs to be perpendicular or parallel to the building lines as necessary. Panels, boxes, covers, etc. shall be mounted in a similar manner. These conditions to be determined using spirit levels.
- .3 Bolts or nuts in a "stripped" or "cross threaded" condition to be replaced immediately.

3.19 COST BREAKDOWN

- .1 Submit to the Owner at time of award of Tenders a cost breakdown of the contract amount for the items described on sheet provided.

3.20 CLEANING

- .1 Do final cleaning in accordance with Division 01 requirements.
- .2 At time of final cleaning, lighting reflectors, lenses, and other lighting surfaces that have been exposed to construction dust and dirt shall be cleaning using soft clothes and approved cleansers.
- .3 Vacuum out all panelboard, cabinet and enclosure tubs and clean all equipment surfaces so they are free of construction dirt and paint.

3.21 YEAR COMPLIANCE

- .1 All products and equipment utilized on this project shall be designed and able to manage dates of more than one century, providing correct dates and times into the 21st century and beyond, including correct leap year calculations.
- .2 The Contractor shall provide testing protocols to confirm their equipment is fully Y2K and Y2K38 (Year 2038) compatible and other potential year with known computing issues (e.g., 2070).
- .3 The Contractor shall agree to repair, replace, or upgrade at not cost to the Owner any failure to comply with these warranties and to reimburse and indemnify the Owner against liabilities or losses it may suffer as a result of such failure.

3.23 PROGRESS BREAKDOWN

DESCRIPTION	CONTRACT AMOUNT	COMPLETED TO DATE	% COMPLETE	PREVIOUS COMPLETE	AMOUNT THIS CLAIM
Intrusion Alarm System					
Electrical Distribution					
Emergency Distribution					
Lighting Fixtures					
MCC Equipment					
Misc. Power & Branch Circuit					
Telephone, Computer, CATV Wiring & Raceways					
Miscellaneous					
TOTAL					

END OF SECTION

1. General

1.1 WORK INCLUDED

- .1 Provide a complete system of wiring, making all connections necessary for the installation shown on drawings.

1.2 SPECIAL CODES

- .1 Install and rate power cables in accordance with the Canadian Electrical Code requirements, or in accordance with IPCEA requirements where permissible.

2. Products

2.1 WIRE

- .1 Conductors outdoors or in wet areas. X-Link: 98% conductivity copper conductors sized as indicated with 600 volt insulation of chemically cross-linked thermosetting polyethylene material, rated RW90 and RWU-90.
- .2 Conductors indoors. X-Link: 98% conductivity copper conductors sized as indicated with 600 volt insulation of chemically cross-linked thermosetting polyethylene material, rated RW90 and RWU-90. Or nylon jacketed thermoplastic insulation type T90 Nylon rated at 600V.
- .3 Luminaire Wire: Copper conductors, #12 A.W.G. with thermoplastic and asbestos insulation type TEW, flame retardant, heat and moisture resistant, rated 600 volts, 105°C.
- .4 Thermoplastic: Copper conductors, #12 AWG with thermoplastic insulation types X-Link, rated at 600 volts.
- .5 Conductors: Stranded for # 8 AWG or larger.

2.2 WIRE CONNECTORS

- .1 Use 3M "Scotchlock," or ideal self-insulated connectors for hand twist wire joints for lighting, small power, and control wiring.
- .2 Use T & B non-insulated ring type compression lugs for terminating #10 AWG and smaller motor connections. Tape with rubber and scotch tape. Lugs to accept ten - 32 x 3/8" machine bolts.
- .3 Terminate conductors #8 AWG and larger with Thomas & Betts Colour-Keyed compression connectors Series 54000, or on lugs provided with equipment.
- .4 Thomas & Betts "KOPR-SHIELD" compound Series CP8 on all terminations for compression connectors.
- .5 Wiring device connections, follow the "good installation practice" of pigtail both the "hot" and the neutral conductors of electrical devices, such as receptacles, so that removal of a device (while lines are hot) cannot result in the disconnection of downstream devices from power nor expose the electrical working to line-to-line voltages that would result from a neutral disconnection.

2.3 ARMoured CABLE

- .1 Conductors: Insulated copper size as indicated, Armour: Interlocking fabricate from aluminum strip.
- .2 Type: AC90

2.4 COMMUNICATION CABLES:

- .1 Structured Communication Cabling to section 27 10 00
- .2 Security Intrusion and Access Control to section 28 16 00

3. Execution

3.1 GENERAL

- .1 X-Link: for all wiring except as specified below. All conductors to be rated RW90 copper unless otherwise shown.
- .2 RW90 for branch circuit conductors, #12 AWG or larger. Use #10 AWG for 120 volt home runs over 30 meters.
- .3 Minimum #14 AWG flexible stranded copper for controls and #12 AWG solid copper for branch circuit power and lighting.
- .4 Luminaire Wire: run wires from outlet boxes through luminaire raceways, splice and connect in raceways. Connect continuous rows of luminaires to circuit without breaking conductors.
- .5 Insulation is to be rated for a minimum of 600VAC unless specified otherwise. Conduit sizes are based on 600V insulation. Adjust conduit size as required for insulation greater than 600VAC.
- .6 Use copper conductors for all feeders. Panel, motor control centres and distribution board feeders may be aluminum alloy if 100 amps or larger.

3.2 WIRECONNECTORS

- .1 Select hand twist connectors for wire size and install tightly on conductors.
- .2 Brush "KOPR-SHIELD" compound on terminations for compression connectors as recommended by the manufacturer.
- .3 Install compression connectors using methods and tools recommended by manufacturer.
- .4 Do not install stranded conductors under screw terminals unless compression lugs are installed.

3.3 WORKMANSHIP

- .1 Before pulling wire, ensure conduit is dry and clean. If moisture is present, thoroughly dry out conduits; vacuum if necessary. To facilitate pulling, recognized specially manufactured wire pulling lubricants may be used. Do not use grease. Employ suitable techniques to prevent damage to wire when ambient temperature is below the minimum permitted for each insulation type. Do not pull wires into incomplete conduit runs.
- .2 Installation to be free of opens and grounds. Before energization, measure insulation resistance and comply with Table 24 of the C.E.C., Part 1. Submit data sheet with values measured.
- .3 Do not install any conductor smaller than #12 AWG, except where specifically indicated otherwise, i.e. for P.A. wiring, etc.
- .4 Provide sizes of conductors as shown on drawings. Voltage drop from branch panels to farthest outlet must not exceed 3% at full load in any case. Advise Owner if problem is foreseen. Voltage drop for conductors from main distribution to branch circuit panelboards shall not exceed 2% under full load conditions.
- .5 Exercise care in stripping insulation from wire. Do not nick conductors.

3.4 IDENTIFICATION, CODING AND BALANCING

- .1 For branch circuit wiring, follow identification system shown on the drawings and as specified in Section 26 05 01.3.5, Identification.
- .2 Connect single phase equipment to minimize imbalance on feeders. Adjust branch circuiting shown as required for optimum balancing. Record all changes on "record" drawings.
- .3 Colour code all feeders at all terminations, at all points where taps are made, and at all panelboards, switchboards, motor control centres, etc. Use two wraps of 3M #471 plastic film tape 48 mm wide.
- .4 Conductors sized No. 10 and smaller are required to be factory coloured, not taped on site.
- .5 For direct current wiring use red for positive and black for negative.

3.5 INSTALLATION OF ARMoured CABLE:

- .1 Minimum wire size shall be AWG# 12.
- .2 Armoured cable may be used for:
 - .1 Final connection to luminaires not exceeding 1.5 m in length.
 - .2 Connection of wiring devices located in millwork.
 - .3 Runs contained in metal or wood stud containing only one or two circuits. Power must be brought first to a junction box within an individual room in conduit. Up to two circuits can be taken from that junction box with in that room using armoured cable.

3.6 TESTING

- .1 All power and control wiring shall be tested for insulation resistance value with a 1000 volt megger. Resistance values shall be as recommended by the cable manufacturer.
- .2 All wire test results shall be properly tabulated, signed, dated, and submitted to the Owner.

END OF SECTION

1. General

1.1 DESCRIPTION

- .1 Supply and install a complete grounding system. Securely and adequately ground all components of the electrical system in accordance with the requirements of all related sections in the latest C.E.C. Section 10 and the local Electrical Inspection Branch.
- .2 The system to consist of cables, ground rods, supports, and all necessary materials and inter-connections to provide a complete system. Measured resistance to ground of the network shall not exceed 5 ohms.
- .3 All ground conductors shall be run in conduit.

2. Products

- .1 Cables 3/0 and smaller to be connected to ground bars via Burndy Quiklug Type QA-2B connectors. Connections for cables larger than 3/0 shall be brazed.
- .2 All ground wires to be stranded copper R-90 complete with a green jacket unless otherwise shown.
- .3 Ground Grid:
 - .1 Ground rods shall be 20 mm x 3650 mm copper flashed or galvanized for first 400 mm.
 - .2 No 3/0 AWG bare copper interconnected conductors.
 - .3 No 3/0 bare copper to main electrical room ground bus.
- .4 Cable to pipe connectors to be made with Burndy GAR connectors.
- .5 In the main electrical room, provide a copper ground bar complete with lugs suitable to terminate all ground cables. See grounding detail on drawing.
- .6 Utility Padmount Transformers Grounding: Provide ground grid in accordance with utility requirements. Confirm supply of transformer grounding with Utility.

3. Execution

3.1 GROUNDING - GENERAL

- .1 All frames and metallic enclosures of all electrical equipment and electrically operated equipment shall be grounded through the conduit system or via a ground wire.
- .2 All transformers, switchgear, motor control centres, panelboards and splitters fed from the main distribution centre shall be grounded by grounding conductors sized in accordance with the C.E.C. The ground wire shall be terminated at each end with an appropriate grounding lug which shall be connected to the equipment ground bus. Ground wire to be green R-90.
- .3 All sub panels such as lighting panels, local distribution panels, etc., shall be grounded with a green ground wire run back to the panel from which it is fed. The ground conductor shall be sized according to the C.E.C.

- .4 All main distribution centres, motor control centres, switchgear, and all panels requiring equipment grounds shall contain a ground bus of adequate size, and tapped for lugs for the ground wire required.
- .5 All bolted connections must be accessible.
- .6 All motors shall be grounded by means of an adequately sized green ground wire contained within the feeder conduit.
- .7 Include a separate green ground wire in all power conduits including branch circuit wiring sized to Table 16, C.E.C.
- .8 Expansion joints and telescoping sections of raceways shall be bonded using jumper cables as per C.E.C.
- .9 Use Burndy compression connectors or approved equal for all grounding splices and terminations unless otherwise shown on the Drawings. For bolted ground connections use Burndy Engineering Company's "Durium" or approved equal hardware.
- .10 Connect all transformer neutrals to the main building ground wire, using compression terminations.
- .11 Install rigid conduit sleeves where ground wires pass through concrete slabs.
- .12 Conduit installed buried in earth or installed in or under grade floor slabs shall have separate ground wire installed, whether the conduits are metal or not.
- .13 Ground all utility services to the electrical system ground.
- .14 Provide ground wires for main telephone/computer rooms as required and shown on drawings.
- .15 Provide #6 AWG bonding conductor in all cable tray bond at each section and as per inspection authority requirements. Ground to main electrical system ground.
- .16 Bond all conduits supplying cabling for systems that uses the cable tray.
- .17 Sound, Fire, and other communications cabinets minimum #12 to each panel or cabinet location.

END OF SECTION

1. General

1.1 WORK INCLUDED

- .1 Supply and install all hangers, supports and inserts for the installation shown on the drawings and specified herein, as necessary to fasten electrical equipment securely to the building structure.

2. Products

2.1 FRAMING AND SUPPORT SYSTEM

- .1 Materials:
 - .1 Intermediate duty supporting structures shall employ P1000 Unistrut or equal together with the manufactures connecting components and fasteners for a complete system.
 - .2 Heavy duty supporting structures to be fabricated and welded from steel structural members and prime painted before installation.
 - .3 Finishes:
 - .1 Outdoors, wet locations: Hot dipped galvanized.
 - .2 Indoors, dry locations: Galvanized when available, prime painted if not available.
 - .3 Nuts, bolts, machine screws: Cadmium plated.
 - .4 Unistrut:
 - .1 Section P1000 or as required for load and span, with mounting screws, or approved. P1000 or equal is a minimum standard for supporting conduits 50 mm and larger.

2.2 CONCRETE AND MASONRY ANCHORS

- .1 Materials: Hardened steel inserts, zinc plated for corrosion resistance. All anchor bolts must be galvanized.
- .2 Components: non-drilling anchors for use in predrilled holes, sized to safely support the applied load with a minimum safety factor of four.
- .3 Manufacturer: Hilti (Canada) Limited or approved equal.

2.3 NON-METALLIC ANCHORS

- .1 Material: Plastic anchors for sheet metal screws.
- .2 Manufacturer: Fischer

2.4 CONDUIT SUPPORTS

- .1 General: Malleable iron one-hole conduit straps where exposed to weather or indoors for conduit smaller than 50 mm. Stamped steel two-hole straps indoors for conduits 50 mm and larger.

- .2 Structural Steel: Crouse-Hinds "Wedgetite" supports or equivalent manufactured by Appleton.
- .3 Masonry, concrete, stone, etc: Lead Anchors.
- .4 Title: Toggle bolts.
- .5 Metal studs, ceiling hangers, etc.: "Caddy-Clips".
- .6 Unistrut: Unistrut conduit clamps.
- .7 Non-metallic not allowed

2.5 CABLE SUPPORTS AND CLAMPS

- .1 General: As per conduit supports, except that for single conductor cables, suitable non-ferrous, or approved stainless steel or aluminum clamps shall be used.

3. Execution

3.1 GENERAL

- .1 Support outlet boxes, junction boxes, panel tubs, etc., independent of conduits running to them. Support conduits within 600 mm of outlet boxes. Support surface mounted panel tubs with a minimum of four 6 mm fasteners.
- .2 Do not cut or drill beams, joists or structural steel unless written permission of the A/E is obtained.
- .3 Distance between conduit or cable supports not to exceed code requirements.
- .4 Supports to be suitable for the real loads imposed by equipment.
- .5 Supports to be securely fastened, free from vibration and excessive deflection or rotation. Maximum deflections are 4 mm over a 1 meter span and 8 mm over a 2 meter span.
- .6 Use metal anchors for all other loads.
- .7 Shot driven pins may only be used with written approval of the structural engineer.
- .8 Use round or pan head screws for fastening straps, boxes, etc.
- .9 Do not support heavy loads from the bottom chord of open web steel joists.
- .10 Install channels in telephone/communication rooms.
- .11 Rack multiple parallel conduit runs on Unistrut support system. Maintain recommended separation between conduits of different systems, e.g. power and low voltage systems.
- .12 Nylon anchors may not be used.
- .13 Fasten exposed conduit to building structure using straps or to exposed beams using beam clamps.

- .14 Suspended support system: Support individual suspended conduits with 6 mm threaded rod and spring clips. Support two or more conduits with on channels supported by min 6 mm threaded rod where direct fastened to building construction id impractical.

END OF SECTION

1. General

1.1 WORK INCLUDED

- .1 Provide a complete system of boxes for the installation of wiring and equipment.

2. Products

2.1 OUTLET BOXES FOR METAL CONDUIT

- .1 Materials:
 - .1 Surface or recessed concealed type: Die formed steel, hot dip galvanized, 1.25 oz/sq. ft. minimum zinc coating.
 - .2 Surface mounting exposed: Cast ferrous for threaded conduit, with attached lugs, corrosion resistant two coats finish.
 - .3 Iberville or approved equal.
- .2 Components:
 - .1 Ceiling outlets, surface mounting, concealed:
 - .2 101 mm square, depth 54 mm, Iberville 52171 series
 - .3 119 mm square, depth 54 mm, Iberville 72171 series
 - .4 Ceiling outlets, concealed mounting in concrete:
 - .5 101 mm octagonal concrete rings, depth from 38 mm to 152 mm Iberville 54521 series.
 - .6 Extension ring to change from recessed conduit to exposed conduit, 101 mm octagonal, 38 mm deep square Iberville (type for all) 53151-1/2 or 38 mm deep octagonal Iberville 51151C or 54 mm deep, Iberville (type for all) 55171C.
 - .7 Wall boxes, concealed in concrete or masonry: for one and two gang applications shall be 101 mm square, 54 mm deep, 52171 series complete with suitable 52-C-49 series square cornered raised tile wall cover for proper device and wall surface application. Masonry boxes may be used for line voltage switching.
 - .8 Wall outlets, concealed non-masonry construction, with plaster finish: For one or two gangs used with switches, receptacles, etc., use 54 mm deep Iberville 52171 series, with matching plaster covers, depth to suit. Alternately, use 119 mm square boxes, Iberville 72171 series and covers as required. (For more than two gangs use solid boxes Iberville GSB series with GBC series cover, or special boxes as required).
 - .9 Wall outlets, surface, exposed mounting or used for outdoor outlets: One or more gang, Crouse-Hinds FS series or FD series, condulet.
 - .10 Covers: Unless wiring devices and plates are mounted, provide blank, round canopy covers to match boxes.

2.2 OUTLET BOXES FOR RIGID PVC CONDUIT

- .1 Materials:
 - .1 Rigid PVC boxes and fittings: Unplasticized PVC.
- .2 Components:
 - .1 Floor boxes: Round with threaded hubs for threaded female connectors.

2.3 JUNCTION BOXES AND PULL BOXES, WEATHERPROOF

- .1 Materials:
 - .1 Cast steel, Crouse Hinds, WBJ Series.

2.4 JUNCTION AND PULL BOXES, INDOOR DRY LOCATIONS

- .1 Materials:
 - .1 Code gauge sheet steel, welded construction, phosphatized and factory paint finish.
- .2 Components:
 - .1 For flush mounting, covers to overlap box by 25 mm minimum all around with flush head cover retaining screws.
 - .2 Use rolled edges for surface boxes.
- .3 Junction boxes mounted in exterior walls shall be complete with box vapour barriers.

2.5 JUNCTION BOXES, SURFACE POWER OUTLETS

- .1 Materials
 - .1 Cast aluminum.
- .2 Components:
 - .1 Single gang, 1/2" hubs for 120V duplex receptacle equal to Iberville C-143 or Commander Perfect Line T11 type.
 - .2 Double gang, 1/2" hubs for quad (double duplex) receptacles equal to Commander Perfect Line LT11 type.

2.6 JUNCTION BOXES AND PULL BOXES FOR COMMUNICATION SYSTEM

- .1 Refer to Section 27 05 28.

2.7 CABINETS

- .1 Materials
 - .1 Cabinets: Code gauge sheet steel, welded construction, phosphatized and factory paint finish, suitable for field painting.
 - .2 Locks: to match panelboards.
 - .3 Backboards: 20 mm GIS fir plywood, one piece per cabinet, covering entire cabinet interior.
- .2 Components:
 - .1 Type E: With hinged door and return flange overlapping sides, with handle for surface mounting, size as indicated or to suit.
 - .2 Type T: Surface or flush with trim and hinged door, latch and lock and two keys, size as indicated or to suit. Keyed to match panelboard keys.

2.8 COMPUTER OUTLET BOXES

- .1 Recessed 4" square box complete with two gang plaster ring are to be used for all computer outlets shown on drawings. All wall enclosures are to be white and be complete with barrier, standard duplex outlet covers, blank covers or designated covers as shown on details on drawings.

2.9 MASONRY BOXES:

- .1 Electro galvanized steel masonry boxes single and multiple gang for devices flush mounted in exposed block walls.

2.10 CONCRETE BOXES:

- .1 Electro galvanized steel concrete boxes single and multiple gang for devices flush mounted in concrete walls with extension rings and plaster rings as required to suite application.

3. Execution

3.1 INSTALLATION

- .1 For flush installation s mount outlet box to allow finish wall to come within 6mm of opening.
- .2 Relocate outlet boxes as directed on site at no extra cost or credit provided that change occurs prior to installation and distance does not exceed, 3.0 m.
- .3 Review the drawings and work of other trades and disciplines to determine best location for electrical outlets and equipment that best uses the available space.
- .4 Prior to roughing in outlets with in a space review the architectural drawings, mill work fitments and elevations to determine the outlet locations Review discrepancies with the owner prior to proceeding.
- .5 Do not install outlet boxes back to back but allow min 150 mm horizontal clearance between boxes.
- .6 Mounting height are from finished grade (AFG) of Above Finished Floor (AFF) unless otherwise noted. If mounting height for a device is not shown confirm height before proceeding. Outlet boxes in masonry should line up with mason course.
- .7 Outlet Boxes:
 - .1 Install all outlets flush and surface mounted as required for the installation.
 - .2 Surface mount above suspended ceilings, or in unfinished areas.
 - .3 Adjust position of outlets in finished masonry walls to suit course lines. Coordinate cutting of masonry walls to achieve neat openings for all boxes.
 - .4 Do not distort boxes during installation. If boxes are distorted, replace with new boxes.
 - .5 Use plaster rings to correct depth. Use 30 mm on concrete block.
 - .6 Do not use sectional boxes.
 - .7 Provide boxes sized as required by the C.E.C.
 - .8 Install vapour barrier material to surround and seal all outlet boxes located on exterior walls of building. Maintain wall insulation.
 - .9 Outlets installed in party walls to be offset by a minimum of one stud space.

-
- .10 Ceiling outlet boxes shall be provided for every surface mounted fixture or row of fixtures installed on suspended "hard" ceilings.
 - .11 Support outlet boxes independently of supporting conduit.
 - .12 Fill boxes with paper, foam to prevent entry of foreign material. Remove upon completion of work.
- .8 Junction Boxes and Pull Boxes:
- .1 Supply all pull boxes and junction boxes shown on the drawings or required for with system name and circuit designation as applicable.
 - .2 Size in accordance with the Canadian Electrical Code, as a minimum.
 - .3 support independently of supporting conduit.
- .9 Cabinets:
- .1 Mount cabinets with top not greater than 1980 mm above finished floor, coordinated with masonry, panelboards, fire hose cabinets and similar items. Securely fasten backboards to cabinet interiors.

END OF SECTION

1. General

1.1 WORK INCLUDED

- .1 Provide a complete system of conduit and fittings for installation of wiring.
- .2 Contractor may install sub-distribution conduit for panel feeders in slab on grade. No panel feeder conduit is to be run in structural slabs. All other conduit work is to be done above ground in ceiling space.

2. Products

2.1 RIGID STEEL CONDUIT

- .1 Galvanized with threaded joints and connections.
- .2 Connections in dry locations: steel or malleable iron locknuts outside enclosures. Insulated bushings Thomas & Betts Type 222 or approved alternate.
- .3 Connectors subjected to moisture interior and exterior: liquid and dust tight with insulated throat, Thomas & Betts "Bullet Hub" 370 Series.
- .4 Fittings: cast metal "Condulet" as manufactured by Crouse-Hinds Canada Ltd. including gasketed covers in damp locations.
- .5 Expansion joints: cast metal Crouse-Hinds type XJ or approved alternate.

2.2 E.M.T. CONDUIT

- .1 Fittings in dry locations: steel set-screw type, coupling and connectors with insulated throats or non-metallic bushings, Thomas & Betts Ltd. Series 5031.

2.3 RIGID P.V.C. CONDUIT

- .1 Conduit: rigid non-metallic conduit of unplasticized polyvinyl chloride C.G.E. "Sceptre" Schedule 40.
- .2 Fittings: threaded male or female solvent weld connectors and solvent weld couplings, as supplied by conduit manufacturer.
- .3 Solvent: as recommended by conduit manufacturer.

2.4 FLEXIBLE CONDUIT

- .1 Connectors: slip-proof, insulated throat or non-metallic bushings, steel, Thomas & Betts Ltd. "Tite-Bite", Series 300.

2.5 LIQUID -TIGHT FLEXIBLE CONDUIT

- .1 Conduit: flexible metal conduit with liquid-tight PVC jacket. Industrial Wire & Cable "Liquidseal".
- .2 Connectors: captive sealing jacket and ground cone insulated throat, steel (Thomas & Betts Ltd. "Super-Tight", Series 6000). Liquid tite connectors for liquid tight conduit.

3. Execution

3.1 RIGID STEEL CONDUIT

- .1 Use as raceways for following applications:
 - .1 In all areas exposed to weather.
 - .2 Locations where mechanical damage may occur and in mechanical rooms to a height of 1 metre.

3.2 E.M.T. CONDUIT

- .1 Use as raceways for following applications:
 - .1 In surface and concealed areas or in poured concrete above ground level.
- .2 It may not be used in damp locations, corrosive atmosphere, underground, outdoors, nor in areas exposed to mechanical damage.

3.3 RIGID P.V.C. CONDUIT

- .1 Use as raceways for following applications:
 - .1 In poured concrete floors and walls and on underground runs exterior to the buildings unless otherwise noted.
 - .2 Wiring installed in areas subject to intermittent or continuous moisture but not surface mounted.
 - .3 Rigid PVC conduit shall not be surface mounted.
- .2 Use strictly in accordance with the C.E.C. Do not use in return air plenums and for exit and fire escape lights.
- .3 Provide insulated ground wire in all rigid PVC conduits in accordance with the C.E.C.
- .4 Where rigid PVC conduit is set in poured concrete, solvent joints must be completed and allowed to set as per manufacturer's instructions.
- .5 Bend rigid conduit in strict accordance with manufacturer's directions. Distorted bends will not be accepted.

3.4 FLEXIBLE CONDUIT AND BX

- .1 Use as raceways for following applications:
 - .1 Flexible connections to luminaires and ceiling mounted devices in suspended ceilings and T-bar.
 - .2 Armoured cable "BX" connections to recessed and/or hanging luminaires. (BX shall not be used to loop between fixtures.)
 - .3 Maximum length of BX to be 1.5 meters from Junction Box.
- .2 Provide a separate insulated ground wire in all flexible conduits.
- .3 Within new drywall partitions to interconnect electrical devices on the same wall, except that the connection from the junction box above the suspended ceiling down to the first electrical device in the drywall shall be wired in EMT conduit.

3.5 RIGID PVC DUCT

- .1 Provide a separate green insulated copper ground wire in all ducts as required by the Code.
- .2 Arrange ducts in a horizontal layer separated by plastic spacers to provide spacing between duct centres, as shown on the drawings.
- .3 Support duct bank on plastic spacers 35 mm between ducts. Foundation spacers to maintain at least 76 mm clearance between ducts and exterior coverage.
- .4 Make joints with tapered couplings to provide a secure watertight connection. Stagger all joints to provide 200 mm vertical and horizontal clearance between adjacent couplings. Where needed, use factory bends to provide bends of radius required.
- .5 When all ducts are installed, brace whole assembly at each spacer group to prevent duct floating when concrete is placed.
- .6 Terminate ducts with standard bell ends where ducts enter cable pits, junction boxes and building interiors.
- .7 Cap ends of unused ducts with plug ends of same material as ducts.
- .8 Seal all joints in ducts with solvent cement.

3.6 LIQUID -TIGHT FLEXIBLE CONDUIT

- .1 Use as raceways for following applications:
 - .1 At all motors, transformers, pipe mounted control devices, and other devices subject to movement or water.
 - .2 At all CTS equipment and kitchen equipment.
- .2 At all motors provide a short length before connecting to the motor terminal box. Minimum length shall be 450 mm plus 4 times the conduit diameter.
- .3 Provide a separate ground wire within flexible conduit, bonded to motor frames and system ground.
- .4 Liquid tight connections required on all liquid tight flex.

3.7 WORKMANSHIP

- .1 Install all conduit and wiring concealed, unless otherwise shown on the drawings. Do not recess conduit in columns, except as noted, without permission.
- .2 Where conduit is run exposed, run parallel to building lines. Where conduits are grouped (two or more), space evenly, make bends concentric and mount on Unistrut racks.
- .3 Lay out conduit to avoid interference with other work. Maintain a minimum clearance of 150 mm from steam or hot water piping, vents, etc.
- .4 Slabs on grade: Install rigid PVC conduit in the gravel base below concrete slabs. Provide mechanical protection around stub-ups through slab and extend 150 mm beyond concrete. When rigid steel conduit is installed in contact with earth it shall be protected by Polykin #940 tape. Extend taping 300 mm above finished grade.

- .5 Metal conduit installations in concrete pours: Tie down conduit to prevent shifting. All joints are to be made up tight to ensure ground continuity. To prevent concrete entry, seal EMT set screw fittings with tape, pack outlet boxes and cap conduit terminations both in boxes and stub-ups. Apply Polykin #940 tape to the conduit 152 mm both sides of the point of leaving slab.
- .6 Do not place conduit in concrete slabs in which slab thickness is less than four times conduit diameter. Place conduits larger than this size under floor. Conduits to have minimum 25 mm concrete cover.
- .7 Organize conduit in slabs to minimize crossovers. Obtain approval and minimum concrete cover required from structural engineer prior to installing conduits in slabs.
- .8 At all recessed panels cap 2 - 25 mm and 4 - 19 mm empty conduits from panel into ceiling above and below for future use.
- .9 Provide Brady underground warning tapes 300 mm below grade above all underground conduits. Tape shall be red, 150 mm wide, catalogue no. 91296.
- .10 Where conduits or ducts enter or exit concrete structures below grade provide 16 mm x 1500 mm steel reinforcing dowels to prevent shearing. Extend dowel 1000 mm beyond concrete and band conduit to dowel. The first 3 meter length of conduit extending from the structure to be Polykin wrapped rigid steel.
- .11 Where conduit is installed in floor slabs to run up at equipment or motors, carefully check all conduit locations. Verify conduit locations for mechanical equipment from shop drawings or detail drawings. Brace all stub-ups. Stub-ups shall be rigid steel.
- .12 Where steel conduit is required to be bent, do not heat, and do not bend conduit in such a way as to reduce pipe cross section area at any point. Radii of bends shall be as per C.E.C.
- .13 For all runs of conduits, do not include more than equivalent of 4 - quarter bends. Provide conduit fittings, pullboxes and junction boxes where necessary. Pulling elbows shall not be used except by special permission.
- .14 Where possible, install conduits so that they are not trapped, cap turned up conduits to prevent the entrance of dirt or moisture during construction. Swab out conduit and thoroughly clean internally before wires and cables are pulled.
- .15 Take extreme care in reaming ends of all conduit to ensure a smooth interior finish that will not damage the insulation of the wires.
- .16 Use insulated non-metallic bushings on all conduit terminations.
- .17 Ensure electrical continuity in all conduit systems.
- .18 All conduit shown exposed in finished areas is to be free of labels and trade marks.
- .19 Install a 90 lb. test line in all conduits left empty by this contractor including those which others will pull cables, wires, etc.
- .20 Conduits and ducts crossing building expansion joints shall have conduit expansion fittings to suit the type of conduit used, and shall be Crouse-Hinds, Sceptre, or FRE.

- .21 Seal conduits with duct seal where conduits are run between heated and unheated areas. Where conduits, cables, or cable trays pierce fire separations, seal openings with Dow Corning 3-6548 sealant.
- .22 Where conduits pass through walls, they shall be grouped and installed through openings. After all conduits shown on the drawings are installed, wall openings shall be closed with material compatible with the wall construction. Review size and quantity of conduit sleeves with the Departmental Representative.
- .23 Where drawings show conduit designations, these conduits shall be identified at each point of termination with Thomas & Betts "Ty-Rap" No. TY532M labels.
- .24 Where conduit finish is damaged, repair or replace.
- .25 Use "Condulet" fittings for power and telephone type conduit terminations in lieu of boxes where support is not provided.
- .26 All branch circuit wiring, home-runs, communication and data to be minimum 20 mm diameter.
- .27 Provide necessary flashing and pitch pockets, making watertight joints where conduits pass through roof or watertight membranes.
- .28 Where panelboard branch circuit conduits are amalgamated, size shall not exceed 25 mm diameter.
- .29 Conduit shall not impede service access to mechanical and electrical equipment. I.e. VAV or filter access on HVAC units.

3.8 CONDUIT IN SLAB

- .1 All conduit with the exception of main shall be installed above finished floor level and shall not be installed in floor slab or underground and are not to penetrate attic space except where specifically indicated.

3.9 CONDUIT UNDER STRUCTURAL SLABS

- .1 All conduits installed below structural slabs are to hung with a minimum 6.3 mm threaded rod and approved conduit clamps at intervals as required by the CEC. Contractor is to examine structural drawings to determine extent of the structural slab.

3.10 CONDUIT BENDS

- .1 For communications conduit system a maximum of 180° bend is permitted between pull boxes. Refer to Section 27 05 28 for additional information.

END OF SECTION

1. General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CAN/CSA C22.2 No. 126-2009, Cable Tray Systems

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 00 10 – Shop Drawings, Product Data, Samples and Mock-ups.
- .2 Identify types of cable tray used.
- .3 Show actual cable tray installation details and suspension system.

2. Products

2.1 CABLE TRAY

- .1 Cable tray and fittings: to CAN/CSA C22.1.
- .2 Continuous, rigid, welded steel wire mesh cable management system.
- .3 Trays: galvanized steel mesh system, welded at all intersections with safety edge T-welded wire lip. Carbon steel wire 4.5mm dia, to ASTM A510 grade 1008.
- .4 Fittings: use only manufacturer recommended fittings.
- .5 Only low voltage systems are to be installed in the cable tray.
- .6 Approved manufacturers are Thomas & Betts Express Tray, Cablofil EZ Tray and Cope Cat-Tray

2.2 SUPPORTS

- .1 Provide supports as required and recommended by the manufacturer at a minimum of 1500mm apart and 600mm from ends.

3. Execution

3.1 INSTALLATION

- .1 Install complete cable tray system.
- .2 Support cable tray on both sides.
- .3 Remove sharp burrs or projections to prevent damage to cables or injury to personnel.
- .4 Bond all sections of the cable tray system to the main communication ground bar using a #6 AWG copper wire.
- .5 Dimensions: Mesh – 50x100mm nominal, straight section lengths – 3 meters, cable tray width 300mm, cable trays depth to be 100mm.

- .6 Communication conduits installed to within 400 mm of cable tray and are longer than 7.5m (from outlet to tray) are to be bonded to the cable tray.

3.2 CABLES IN CABLE TRAY

- .1 Install cables individually.
- .2 Lay cables into cable tray. Use rollers when necessary to pull cables.
- .3 Secure cables in cable tray at 6m centres, with milk-tie wraps.
- .4 Identify cables every 30m with size 2 nameplates in accordance with Section 16040.
- .5 Lighting or power cables shall not be installed in the cable tray.
- .6 Cable tray fill shall not exceed forty percent (40%).

3.3 FIRE BARRIERS

- .1 Cable tray to run to within 450mm of Fire Rated Walls. Conduits (minimum 6-53mm conduits) to run between cable trays on either side of fire rated walls. Provide fire stopping at wall penetrations. Arrange and make good-fire rating of walls after conduits have been installed.
- .2 Or run cable tray to within 100 mm of wall and install fire rated cable pass through for full capacity of the tray. As STI EZ -Path series 33 pass through.

END OF SECTION

1. General

1.1. SCOPE

- .1 The work under this section includes underground cast-in-place concrete ductbanks for electrical power and signal system distribution. The term "signal" is used thorough this specification as a generic term to include communications, control, security and other low voltage systems. Included are the following topics:

1.2. RELATED WORK

- .1 Applicable provisions of Division 1 govern work under this Section
- .2 Section 26 05 44 – Manholes
- .3 Section 26 08 00 - Commissioning of Electrical
- .4 Section 01 91 01 or 01 91 02 – Commissioning Process

1.3. SUBMITTALS

- .1 Indicate material specifications, and provide product data on conduit, spacers, terminators, reinforcing steel and related components.

2. Products

2.1. CONDUIT

- .1 Size: 5" nominal for voltages above 600V, and 4" nominal for 600V or lower and communication system applications.
- .2 Material: Rigid polyvinyl chloride (PVC) marked at uniform intervals to indicate the kind of material; type Schedule 40 heavy wall, type EB-20 (TC-6), or type EB-35 (TC-8). Type EB conduit is rated for use only in concrete encased applications.

2.2. ELBOWS

- .1 Material to match conduit; minimum bend radius of 36 inches (915 mm).

2.3. SPACERS

- .1 Plastic, to maintain 3" minimum between conduits.

2.4. CONDUIT TERMINATION IN MANHOLES AND BUILDINGS

- .1 Bell Ends: Manufactured bell ends of appropriate sizes at each end of conduit. When entering a new building or a new manhole a pre-manufactured PVC bell end system (as manufactured by Formex or similar) with conduit seals, provisions for roughing into the concrete and water stops is allowed.
- .2 Seals: When entering an existing building or manhole below grade, the concrete shall be core drilled for the appropriate size conduit and seal. The seal shall be a mechanical interlocking assembly of modular rubber links properly sized to fit the pipe and tightened in place, in accordance with the manufacturer's instruction.
- .3 Bushings: Steel grounding bushings shall be used on all metal conduits entering a building or manhole.

2.5. PLUGS

- .1 Expandable pipe plug, gas and water tight, for sealing empty conduit. Plug shall be high impact plastic with an outer rubber gasket expandable by hand tightening a wing nut on a central spindle.
- .2

2.6. PULL TAPE

- .1 Polyester pull tape, 1/2" width, tensile strength of 1,250 lbs. with sequential footage markings along the entire length of the tape as manufactured by Greenlee, Carlon, Garvin Industries, or Neptco (Muletape). Install pull tape in each empty conduit.

2.7. GROUNDING

- .1 Steel grounding bushings shall be grounded to manhole or junction box ground.

2.8. DRAINAGE ASSEMBLY

- .1 All ducts shall drain to an open end - preferably a manhole.

2.9. CONCRETE ENCASEMENT

- .1 Concrete used throughout shall be ready mixed concrete furnished by an approved mixing plant. The plant shall comply with the requirements of National Ready Mixed Concrete Association certification plan.
- .2 The concrete mix used with type Schedule 40 heavy wall conduit shall be 3000 psi minimum, 3/4" aggregate.
- .3 The concrete mix used with type EB-20 (TC-6), or type EB-35 (TC-8) thin wall conduit shall be 2500 psi minimum, 3/8" pea gravel aggregate.
- .4 The slump shall be just enough to allow the mix to flow to the bottom of the formation and yet not be so wet as to cause the ducts to float.
- .5 Encase duct with 3 in. minimum of concrete on top, bottom, and sides with top of duct bank troweled to a smooth crown to prevent pooling of water.

2.10. REINFORCING STEEL

- .1 Provide reinforcing steel the entire length of the duct system, four - #4 bars - one in each corner, minimum, or as shown on the drawings. Tie or dowel the reinforcement steel into the connecting walls of manholes, vaults and buildings, etc. to protect against vertical shearing.

2.11. UNDERGROUND WARNING TAPE

- .1 Detectable underground warning tape, 2" wide minimum, 5 mil thickness, containing a foil core as manufactured by Presco, Seton, or similar.
- .2 Tape color and labeling shall be as follows:
 - .1 Electrical Power Systems: Red color and labeled with the words "CAUTION-BURIED ELECTRIC LINE BELOW" or similar.
 - .2 Communication Systems: Orange color and labeled with the words "CAUTION-BURIED COMMUNICATION LINE BELOW" or similar.

3. Execution

3.1. EXCAVATIONS

- .1 Excavate trenches for ductbank to adequate width, depth, and proper slope as specified.
- .2 Install forms on sides of ductbank if trench is not of proper firmness to prevent cave-in.
- .3 The trench sidewall shall be less than 6 inches from the edge of the conduit being installed. Install forms if needed to limit the trench width.

- .4 Bottom of trench shall be undisturbed earth. If trench bottom is too low for proper grade, fill to proper level with sand and mechanically compact it.
- .5 Each excavated section from manhole to manhole and from manhole to building shall be completely excavated and graded before any duct is laid in that section.

3.2. PLACEMENT OF CONDUIT

- .1 Install flush bell ends on duct at manholes and buildings. When entering a new building or a new manhole, a pre-manufacture end bell system (by Formex or similar) with conduit seals is allowed.
- .2 When entering an existing building or manhole, core drill existing walls and waterproof using a mechanical seal of assembled rubber links properly sized for the pipe and tighten in place, in accordance with the manufacturer's instruction, after the new conduit is installed.
- .3 Install spacers as recommended by conduit manufacturer and requirements stated above, but not to exceed a maximum of 6 ft-0 in. on center for PVC conduit and 8 ft-0 in. on center for steel conduit. Bottom spacers shall rest on 8" X 16" X 2" concrete pads to prevent them from sinking into the ground and reducing the bottom concrete cover. Stagger conduit joints in concrete encasement 6 in. minimum horizontally.
- .4 Tie the conduit assembly down at regular intervals so it does float up in the concrete during the pour.
- .5 Pitch conduit properly for drainage to manhole and to prevent low pockets or irregular dips between conduit ends. Pitch conduit away from building and toward manhole. Minimum pitch to be 4 inches per 100 feet.
- .6 Install not more than one 90 degree bend or equivalent between manholes for primary conduit and two 90 degree bends or equivalent for signal conduit.
- .7 In ductbanks with both primary and signal conduit, primary conduit shall be straight and the signal conduit shall contain bends as necessary to accommodate the primary duct.
- .8 Install insulated grounding bushings on steel duct ends.
- .9 Install closure plugs in all empty conduits at manhole and building entrances and at terminations in equipment pedestals to prevent the entrance of water, sediment and vapors.

3.3. PLACEMENT OF REINFORCING BARS

- .1 At new building and manhole walls, tie duct bank and wall reinforcing steel together to provide a permanent connection.
- .2 At existing building and manhole walls, dowel reinforcement bar into the wall to provide protection against vertical shearing. Use epoxy adhesive to secure the dowels.
- .3 Install the bars - one in each corner, minimum or as shown on the drawings, overlap the joints 12" and tie into the connecting walls of manholes, vaults, and buildings, etc.

3.4. PLACEMENT OF CONCRETE

- .1 After ducts are in place and before the concrete is poured, the installation shall be inspected by the DFD Construction Representative. Notify the Construction Representative at least two days before the time of inspection.
- .2 The Contractor shall supervise the placement of concrete in the ductbank.
- .3 Complete entire section of conduit from manhole to manhole or from manhole to building before encasement by concrete.
- .4 Top of concrete envelopes shall be not less than 24 inches below grade.

- .5 In placing concrete around the conduit, adjust delivery chute so the fall of the concrete into the trench is minimal.
- .6 Vibrating is not allowed as it tends to cause the conduit to float up in the concrete.
- .7 Provide minimum of 3" (76 mm) of concrete cover over conduit at the top, bottom and sides with top of duct bank troweled to a smooth crown to prevent pooling of water.
- .8 Place concrete continuously from manhole to manhole to building without interruption.
- .9 Extend concrete envelope to finish floor grade or interior wall surface in buildings and finish pad grade at equipment. Maintain moisture seal.

3.5. BACKFILL

- .1 Compact backfill around ductbank.
- .2 Install warning tape 12" below finish grade over all ductbanks. For ductbanks more than 24" wide, install multiple runs of warning tape no farther than 18" apart. The warning tape shall not be farther than 12" from the ductbank edge.

3.6. RESTORATION

- .1 After completion of ductbank installation, return all ground and pavement surfaces to original condition or to condition as indicated on the drawings. This includes all sidewalks, curbs, streets, parking areas, lawns, plantings, etc.

3.7. ACCESSORY INSTALLATION

- .1 Pull a mandrel/swab (diameter 1/4 in. smaller than conduit) through each conduit in completed ductbank to insure adequate opening of duct run.
- .2 Install pull tape with measurement markings in each empty duct.
- .3 Install closure plugs in all empty conduits at manhole and building entrances and at terminations in equipment pedestals to prevent the entrance of water, sediment and vapors.
- .4 Ground all steel bushings to manhole or junction box ground.

3.8. CONSTRUCTION VERIFICATION

- .1 Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 26 08 00 in accordance with the procedures defined for construction verification in Section 01 91 01 or 01 91 02.

END OF SECTION

1. General

1.1 RELATED REQUIREMENTS

- .1 Electrical General Requirements Section 26 05 01

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS

- .1 Conduit Section 26 05 33

2. Products

2.1 COMPONENTS

- .1 Conduit: Type Rigid PVC Duct, DB2 otherwise.
- .2 Concrete: 20 MPa with additive to give permanent red colour - 20 mm maximum aggregate size.
- .3 Markers: Markers shall be square with 25 mm letters.
- .4 Conductors: Refer to Section 26 05 19
- .5 Cable Lugs: Suitable for the application and use as required by the Canadian Electrical Code, approved by the electrical inspection authority and acceptable to the local supply authority.

3. Execution

3.1 INSTALLATION

- .1 Installation shall be on undisturbed soil or on well compacted granular fill, 150mm thick.
- .2 Install at minimum of 1 meter below finished grade.
- .3 Install rigid PVC conduit in configuration indicated. Spacers installed at maximum intervals of 1.5 meters.
- .4 Clean conduits before laying. Cap ends during construction and after installation to prevent entrance of foreign materials.
- .5 Route of conduit runs shall be marked with marking tape, Brady Identoline, laid in trench approximately 300mm below grade.
- .6 Check all conduits for clear bore before backfilling. Install fish wires in all conduits.
- .7 Coordinate routing and depth of all conduits with General Contractor.
- .8 Conduits shall be encased in concrete where run below parking or vehicle traffic areas.

3.2 DUCT BANK INSTALLATION

- .1 Provide reinforcing rods and band ties over entire length as detailed.
- .2 Ensure that concrete fills all voids around ducts.

- .3 Lay PVC ducts with configuration and reinforcing as indicated with preformed interlocking, rigid plastic intermediate spacers to maintain spacing between ducts at not less than 40 mm horizontally and vertically. Stagger joints in adjacent layers at least 150 mm and make joints watertight. Encase duct bank with minimum 75 mm thick concrete cover on all sides.
- .4 Slope ductbanks 150 mm per 30 m minimum to drainage point. Adjust final slopes on site to coordinate with existing utilities. Slope away from building.
- .5 Provide drain holes not less than 12 mm in diameter in each conduit and provide a fabricated 50 mm drain assembly with saddle cutouts for each conduit fitting over the drain line. Tape drain assembly to each conduit to prevent entrance of concrete. Band drain assembly with 12 mm stainless steel straps to conduit assembly to prevent mechanical displacement.
- .6 Install on undisturbed soil where possible. Backfill required to be compacted pit run gravel and sand, 200 mm lifts maximum.
- .7 Clean and swab all ducts. Install galvanized iron pullwires in spare ducts. Cap spare ducts.

3.3 SERVICE INSTALLATION

- .1 General routing to follow that indicated on drawings.
- .2 Contractor to provide required trenching backfill etc. to install primary & secondary feeders, Telus, Cable TV and Supernet underground in coming conduits. Coordinate with Utility.

END OF SECTION

1. General

1.1 SUMMARY

- .1 All electrical fittings, supports, hanger rods, pull boxes, channel frames, conduit racks, outlet boxes, brackets, clamps, etc. to have galvanized finish or enamel paint finish over corrosion-resistant primer.
- .2 All panelboards, distribution centres, motor control centres, transformers, etc. to be factory finished in alkyd high gloss enamel applied over corrosion-resistant primer. Matte or flat type finish paint not acceptable. Factory finished units that are scratched or marked during installation or shipping to be touched up with matching spray-on air dry lacquer or, if required to provide a satisfactory job, completely refinished.
- .3 All panelboards, distribution centres, transformers, motor control centres, low voltage cabinets, pull boxes and raceways to be colour coded as follows. The exact colour to be approved by the architect prior to manufacture.
- .4 All 120/208 volt equipment including pull boxes and raceways to be finished in grey.
- .5 Transformer enclosures to be finished in accordance with primary voltage colour as outlined above.
- .6 Low voltage switching terminal cabinets and pull boxes to be finished in black.
- .7 Telephone terminal panels and junction boxes to be finished in green.
- .8 Public address terminal panels and junction boxes to be finished in yellow.
- .9 Security terminal panels and junction boxes to be finished in orange.
- .10 R.F. television and satellite system pull boxes and junction boxes to be finished in ivory.

1.2 NAMEPLATES

- .1 Clearly identify all major electrical equipment including main distribution centres, sub-distribution panels, power panels, lighting panels, disconnect switches, starters, contactors, motor control centres, terminal cabinets and panels, pushbuttons and selector switches, etc. by permanent labels described below.
- .2 Provide nameplates of lamicoid plastic with black back showing 10 mm white letters mounted in conspicuous location on the surfaces of the equipment, except in finished areas locate nameplates in flush panels mounted on panel front inside enclosure.
- .3 Nameplates to be black/white/black giving white letters on black background for all normal power equipment. Nameplates to be red/white/red giving white letters on red background for all emergency power equipment.
- .4 All nameplates to include equipment name and designation number as shown on drawings, and voltage rating. All nametags to be attached to the outside of panel doors and equipment enclosures.

- .5 In terminal cabinets for control wiring, low voltage relays, intercommunication, telephone, clock, etc. Identify terminal strips, etc. utilizing 9.5 millimetre roll adhesive back embossed type nametags.
- .6 Transformers: identify as shown on drawings showing capacity and primary and secondary voltages.
- .7 Disconnect switches, starters and contactors indicate equipment being controlled and voltage.
- .8 Terminal cabinets and pull boxes: indicate system and voltage.
- .9 On/Off switches: indicate equipment being served.
- .10 Distribution centres: identify distribution centres as indicated on drawings and main voltage or voltages if more than one.
- .11 Motor control centres: identify as shown on drawings and show main voltage or voltages if more than one.
- .12 Surface raceway normal and emergency receptacles: identify panel and circuit number.
- .13 All receptacles: identify panel and circuit number. Special receptacles to be identified by architect. Confirm identification method with PCA Departmental Representative.
- .14 Receptacles and light switches: use Kroy label showing panel and circuit numbers.
- .15 Ceiling mounted junction boxes: use permanent marker showing panel and circuit numbers on junction boxes or on slab beside junction boxes.
- .16 Emergency lighting remote heads to be with lamacoid with battery pack designation on the base.
- .17 Battery packs to be labelled with lamacoid with battery pack designation.

1.3 CABLES

- .1 Clearly label all ends of low voltage system cables to conform with EIA/TIA 606 standards. Use wire sleeves equal to Brady LS2000 series. The label shall not be handwritten and shall be affixed to the cable jacket.

END OF SECTION

1. General

1.1. SCOPE

- .1 The electrical contractor shall retain the services of an independent third party firm, or the equipment manufacturer's technical services group, to perform a short circuit/coordination study and arc flash risk assessment as described herein.
- .2 Preliminary studies shall be submitted to the A/E prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment for manufacture to ensure the characteristics and ratings of the proposed overcurrent devices will be satisfactory. The final submittal shall capture any changes in circuit lengths, wire sizes, Additionalloads, etc. that may occur during the construction project.
- .3 The studies shall include all portions of the electrical distribution system from the normal power source or sources, and emergency/standby sources, down to and including the smallest circuit breaker in the distribution system (for short circuit calculations). Normal system connections and those which result in maximum fault conditions shall be adequately covered in the study.
- .4 The firm should be currently involved in medium- and low-voltage power system evaluation. The study shall be performed, stamped and signed by a registered professional engineer in the State of Wisconsin. Credentials of the individual(s) performing the study and background of the firm shall be submitted to the A/E for approval prior to start of the work.
- .5 The firm performing the study should demonstrate capability and experience to provide assistance during start up as required.
- .6 The study and assessment shall be performed on SKM Dapper, Capter and PowerTool software or EasyPower product suite software.

1.2. RELATED WORK

- .1 Applicable provisions of Division 1 govern work under this section
- .2 Section 26 14 13 – Switchboards
- .3 Section 26 24 16 – Panelboards
- .4 Section 01 91 01 or 01 91 02 – Commissioning Process

1.3. REFERENCE STANDARDS

- .1 Standards listed in the IEEE "Buff Book", latest edition
- .2 National Fire Protection Association (NFPA) 70E, latest Facility
- .3 IEEE 1584 – Guide for Performing Arc Flash Calculations

1.4. DATA COLLECTION FOR THE STUDY

- .1 The contractor shall provide the required data for preparation of the studies. The engineer performing the system studies shall furnish the contractor with a listing of the required data immediately after award of the contract.
- .2 The contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to release of the equipment for manufacture.

1.5. SUBMITTALS

- .1 THIRD PARTY QUALIFICATIONS: Submit qualifications of individual(s) who will perform the work to the A/E for approval prior to commencement of the studies.
- .2 PRELIMINARY REPORT: Submit a draft of the studies to the A/E for review prior to delivery of the final study to the Owner. Make all Facility's or changes as required by the reviewer.
- .3 FINAL STUDY REPORT: Provide studies in conjunction with equipment submittals to verify equipment ratings required.
- .4 The results of the power system studies shall be summarized in a final report and provided in the following formats. Provide (2) bound hard copies of the final report. Provide (2) electronic copies (on CD) of the final report and one-line diagrams in PDF format. Provide (2) electronic copies (on CD) of the final report in MS Word format and the one-line diagrams in CAD format.
- .5 Also provide (2) electronic copies (on CD) of all files generated by the SKM or EasyPower software for all scenarios evaluated in the studies. The files shall permit the studies to be opened, reviewed or updated by any user of the analysis software used for the studies.
- .6 The report shall typically include the following sections:
 - I. Overview
 - II. Short Circuit Study
 - SC-1 Purpose
 - SC-2 Explanation of Data
 - SC-3 Assumptions
 - SC-4 Analysis of Results
 - SC-5 Recommendations
 - SC-6 Fault Analysis Input Report from Software Program
 - SC-7 Fault Contribution Report
 - III. Protective Device Coordination Study
 - PDC-1 Purpose
 - PDC-2 Explanation of Data
 - PDC-3 Assumptions
 - PDC-4 Analysis of Results
 - PDC-5 Recommendations (Including NEC 700-27 Requirement)
 - PDC-6 Results from Software Program
 - PDC-7 Example Drawings
 - IV. Arc Flash Study
 - ARC-1 Purpose
 - ARC-2 Explanation of Data
 - ARC-3 Assumptions
 - ARC-4 Analysis of Results
 - ARC-5 Recommendations
 - ARC-6 Arc Flash Evaluation Report from Software Program
 - V. Prioritized Recommendations and Conclusions
 - VI. Appendices
 - APP-1 One-line Diagrams from Software Program
 - APP-2 AutoCAD One-line Diagrams
 - APP-3 Protective Device Summaries from Software Program
 - APP-4 Reference Data
 - APP-5 Sample Work Permit Form
 - APP-6 Copy of Warning Labels, including study date
- .7 The above sections shall include the following items in detail:
 - Obtain available fault current from the local utility company.
 - Short circuit studies shall evaluate the available fault current at each bus (each change of impedance), including all three-phase motors.

- Coordination study recommendations for relay settings, breaker settings, and motor protection settings.
- Recommendations for improving the coordination and/or load distribution, as well as ground fault requirements.
- Worst case Arc Flash values (highest incident energy) for project specific scenarios (low short circuit and high short circuit for each possible power supply source).
- Arc flash values for two maintenance cases, which define the arc flash values available at the equipment that would be available if the instantaneous trip of the upstream circuit breaker is set at a minimum value. This is recommended if someone has to work on live equipment.
- IEEE standard one-line diagram with equipment evaluation and circuit breaker settings that clearly define the system data and are easy to interpret. The diagrams should include the bus names and references used in the studies.
- Recommendations to reduce the arc flash incident energy in all areas that are subject to 8 calories per square centimeter or greater of available incident energy.
- Condition of Maintenance information for any existing equipment included in the study.
- Prioritized report summarizing all recommendations from this study. This shall include observed NEC code violations and their corrective action.
- The contractor shall provide a one-line diagram that meets IEEE/ANSI standard 141, mounted on 24" x 36" (minimum) Styrofoam backboard. This one-line diagram shall be mounted in each electrical room.

2. Products

2.1. Not used.

3. Execution

3.1. SHORT CIRCUIT AND COORDINATION STUDY

- .1 The short circuit, coordination, and arc flash hazard studies shall be performed using SKM Dapper, Captor and PowerTool for Windows software or EasyPower product suite Windows based software packages. In the short circuit study, provide calculation methods and assumptions, the base per unit quantities selected, one-line diagrams, source impedance data including power company system characteristics, typical calculations, and recommendations. Calculate short circuit interrupting and momentary (when applicable) duties for an assumed 3-phase bolted fault at each supply switchgear lineup, unit substation primary and secondary terminals, low voltage switchgear lineup, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboard, and other significant locations throughout the system. Provide a ground fault current study for the same system areas, including the associated zero sequence impedance data. Include in tabulations fault impedance, X to R ratios, asymmetry factors, motor contribution, short circuit KVA, and symmetrical and asymmetrical fault currents.
- .2 In the protective device coordination study, provide time-current curves graphically indicating the coordination proposed for the system, centered on conventional, full-size, log-log forms. Include with each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered by that particular curve sheet. Include a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Tabulate recommended device tap, time dial, pickup, instantaneous, and time delay settings.

- .3 Include on the curve sheets power company relay and fuse characteristics, system medium-voltage equipment relay and fuse characteristics, low-voltage equipment circuit breaker trip device characteristics, pertinent transformer characteristics, pertinent transformer characteristics, pertinent motor and generator characteristics, and characteristics of other system load protective devices. Include at least all devices down to largest branch circuit and largest feeder circuit breaker in each motor control center, and main breaker in branch panelboards.
- .4 Include all adjustable settings for ground fault protective devices. Include manufacturing tolerance and damage bands in plotted fuse characteristics. Show transformer full load and 150, 400, or 600 percent currents, transformer magnetizing inrush, ANSI transformer withstand parameters, and significant symmetrical and asymmetrical fault currents. Terminate device characteristic curves at a point reflecting the maximum symmetrical or asymmetrical fault current to which the device is exposed.
- .5 Select each primary protective device required for a delta-wye connected transformer so that its characteristic or operating band is within the transformer characteristics, including a point equal to 58 percent of the ANSI withstand point to provide secondary line-to-ground fault protection. Where the primary device characteristic is not within the transformer characteristics, show a transformer damage curve. Separate transformer primary protective device characteristic curves from associated secondary device characteristics by a 16 percent current margin to provide proper coordination and protection in the event of secondary line-to-line faults. Separate medium-voltage relay characteristic curves from curves for other devices by at least a 0.4-second time margin.
- .6 Include complete fault calculations as specified herein for each proposed and ultimate source combination. Note that source combinations may include present and future supply circuits, large motors, or generators as noted on drawing one-lines.
- .7 Utilize equipment load data for the study obtained by the Contractor from contract documents, including contract addendums issued prior to bid openings.
- .8 Include fault contribution of all motors in the study. Notify the Engineer in writing of circuit protective devices not properly rated for fault conditions.
- .9 Provide settings for the chiller motor starters or obtain from the mechanical contractor, include in the study package, and comment.
- .10 When an emergency generator is provided, include phase and ground coordination of the generator protective devices, to meet NEC 700.27 requirements. Show the generator decrement curve and damage curve along with the operating characteristic of the protective devices. Obtain the information from the generator manufacturer and include the generator actual impedance value, time constants and current boost data in the study. Do not use typical values for the generator.
- .11 Evaluate proper operation of the ground relays in 4-wire distributions with more than one main service circuit breaker, or when generators are provided, and discuss the neutral grounds and ground fault current flows during a neutral to ground fault.
- .12 For motor control circuits, show the MCC full-load current plus symmetrical and asymmetrical of the largest motor starting current to ensure protective devices will not trip major or group operation.

3.2.

FIELD SETTINGS

- .1 The Contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short circuit study, protective device coordination study and arc flash risk

assessment.

- .2 Necessary field settings and adjustments of devices and minor modifications to equipment to accomplish conformance with the approved short circuit and protective device coordination study shall be carried out by the Contractor at no additional cost to the owner.

3.3. ARC FLASH RISK ASSESSMENT

- .1 As part of the short circuit and coordination study, arc flash risk assessment shall be included. The study shall include the following:
 - .1 Determine and document all possible utility and generator/emergency sources that are capable of being connected to each piece of electrical gear. Calculations shall be based on highest possible source connection.
 - .2 Calculations to conform to National Fire Protection Association (NFPA) 70E recognized means of calculation standards. All incident energy units shall be calculated in calories per square centimeter.
 - .3 Provide recommended boundary zones and personal protective equipment (PPE) based on the calculated incident energy and requirements of NFPA 70E for each piece of electrical gear.
 - .4 Electrical Contractor shall provide warning labels as required by OSHA based upon the results of the arc flash risk assessment. At a minimum, the labeling shall contain the following information: nominal system voltage, arc flash boundary, limited approach boundary, restricted approach boundary, available incident energy and the corresponding working distance or the arc flash PPE category, minimum arc rating of clothing, and study date. Label shall also include the name or logo and the phone number of the company performing the study.
 - .5 Arc flash warning labels shall be affixed to all electrical equipment that is likely to require examination, adjustment, servicing or maintenance while energized. This includes, but is not limited to, medium-voltage switchgear, transformers, switchboards, panel boards, three-phase disconnect switches, transfer switches, motor control centers, motor controllers, and three-phase motor disconnect switches.

END OF SECTION

1. General

1.1 RELATED WORK

- | | | |
|----|-------------------------------------|------------------|
| .1 | Motor Starters | Section 26 24 19 |
| .2 | Connections to Mechanical Equipment | Section 25 30 01 |

2. Products

2.1 NAMEPLATES

- .1 Lamacoid, white with black lettering except for equipment connected to the emergency supply for which orange nameplates with black letters are to be used.

3. Execution

3.1 IDENTIFICATION

- .1 Label every motor to show the motor number, the motor name and power source.
Example:

"MOTOR #3-51, EMERGENCY EXHAUST, CCT. EAA2-4"

Label every starter to show motor it controls. Coordinate with all Divisions, equipment names and numbers to be identical.

3.2 NAMEPLATES

- .1 Permanently fasten the nameplates to the equipment, so as to be clearly visible.

3.3 MOTOR SURVEY AND CONTROL WIRING DIAGRAMS

- .1 Make a complete survey of all electric motors. For every motor and starter, fill in the Motor Survey sheets illustrated herein. List each motor on a separate page. Attach a control wiring diagram neatly drawing in ladder form for each motor. Indicate all terminal and wire numbers. Identify all associated control components. Provide typed copies of these lists and diagrams in the Operating/Maintenance Manuals. Include motor overload selection charts for each type and application of overload relay.
- .2 Instruments used shall be digital with an accuracy of $\pm 2\%$.

END OF SECTION

1. General

1.1 INTENT

- .1 Provide demonstration and instruction sessions to familiarize Owner's operation and maintenance personnel with electrical systems and their operation and maintenance.
- .2 Submit system sign off sheets for each system listed after substantial completion.
- .3 Complete a motor survey sheet for each motor and submit after substantial completion. Include a control wiring diagram for each motor neatly drawn in ladder form. Indicate all terminal and wire numbers. Identify all associated control components. Provide typed copies of these lists and diagrams in the operating/maintenance manuals. Include motor overload selection charts for each type and application of overload relay.
- .4 All sign off and survey sheets shall be typewritten.

1.2 MANUFACTURER'S SITE SERVICES

- .1 Arrange and pay for appropriately qualified manufacturers representatives to provide or assist in providing electrical equipment and system demonstration and instruction as specified herein.

1.3 CONTRACTOR/OWNER COORDINATION

- .1 Owner will chair demonstration and instruction sessions.
- .2 Establish agendas for demonstration, commissioning and instruction sessions in conjunction with Owner. Coordinate scheduling of sessions with Owner and PCA Departmental Representative.

2. Products

- .1 NotApplicable

3. Execution

3.1 SYSTEMS DEMONSTRATION

- .1 Demonstrate operation of following systems:
 - .1 120/208 and 347/600 Volt System Emergency and Normal
 - .2 Pump Protection Panels
 - .3 Mechanical Equipment Connections and Controls
 - .4 Grounding System
 - .5 Intercom System
 - .6 Lighting
 - .7 Lighting Controls
 - .8 Future Connection Points and Conduit Stubs

MOTOR SURVEY SHEET

Motor Name & Number _____

Manufacturer _____

H.P. _____ Max. Ambient _____ °C

R.P.M. _____ Service Factor _____

Volts _____ / _____ / _____ Insulation Class _____

AMPS _____ / _____ / _____ EEMAC Design _____

PHASE _____ Time Rating _____

Frame _____ Type _____

Serial # _____

Model # _____

Starter _____ Type _____

Full Load Operating Amps _____ A _____ B _____ C _____

Capacitor Operating Amps _____ A _____ B _____ C _____

Full Load Operating Voltage _____ A-B _____ B-C _____ C-A _____

at Motor

Power Factor _____

Overload Relay Installed _____ Adjustable Setting _____ %

M.C.P. AMPS _____ Adjustable Setting _____

Acceleration Time (If over 7 seconds) _____

Reduced Voltage Starter Transition Time Setting _____

Special Controls and Remarks (Thermistor and Relay Type, Capacitors and where connected, etc.)

SYSTEM COMPLETION AND COMMISSIONING

SYSTEM: _____

The above system is installed as per the drawings and specifications, is complete and has been commissioned.

Electrical Contractor

Signed by: _____ Dated: _____

General Contractor

Signed by: _____ Dated: _____

Deficiencies Attached

This system has been reviewed by:

The Owner

Signed by: _____ Dated _____

The Owner's personnel have been instructed in the operation and maintenance of the above system:

The Owner

Signed by: _____ Dated _____

The above does not constitute a waiver of any of the requirements of the Contract Documents.

ELECTRICAL
CONTRACTOR

GENERAL
CONTRACTOR

Address: _____

Phone: _____

END OF SECTION

1. General

1.1 RELATED WORK

- | | | |
|----|----------------------|------------------|
| .1 | Motor Starters | Section 26 24 19 |
| .2 | Motor Identification | Section 25 05 82 |
| .3 | Mechanical | Section 23 00 00 |

1.2 REQUIREMENTS

- .1 Provide a complete system of wiring to motors and controls as specified herein and as shown on the drawings.
- .2 Unless specifically noted otherwise, wire and leave in operation all electrically operated equipment supplied under all contracts related to this project. Examine the drawings and shop drawings of all Divisions for the extent of electrically operated equipment supplied under other contracts.
- .3 All control wiring diagrams shown on the drawings illustrate typical control circuits applicable to the equipment. Control circuits may vary with different manufacturers of equipment. Verify all control circuits with the suppliers of the equipment and make any corrections that may be required.
- .4 Unless specifically noted otherwise, provide all line voltage equipment such as, but not limited to, pushbuttons, relays, thermal overload protection, starters, conduit and wire, etc., necessary for the operation of equipment. Check all starters, relay coils and thermal elements to ensure that they provide the necessary protection for motors.
- .5 Do not operate motors and controls until approval is obtained from the trade providing equipment.
- .6 Examine drawings and shop drawings of other Divisions to obtain exact location of motors and equipment shown on drawings. Where necessary, obtain conduit locations from other trades' drawings and shop drawings.
- .7 Assist in placing in operation all mechanical equipment having electrical connections.
- .8 Provide three phase starters with fused 120 volt control transformers and overload relays.
- .9 Provide all power wiring for all motors and control wiring as indicated on the drawings.
- .10 In general, wiring for freeze stats, fire stats, E.P. switches, P.E. switches, dampers, temperature controllers, flow switches, solenoid valves, etc., for heating ventilating and air conditioning equipment will be under a separate contract. Provide terminations in starters and MCC's for control wiring so that starter control circuits may be extended. Where 120 volt power is required for mechanical equipment, i.e. roll type filters, refrigerated aftercoolers, control cabinets, etc. wiring to the equipment terminals is the work of this Division.
- .11 Refer to Motor Control Equipment Schedule.

.12 Some specific definitions of equipment wiring responsibilities are as follows:

.1 Fans

.1 Provide all 120V and 208V power wiring. Except where specifically noted otherwise, all control for fans is to be supplied, installed and wired from the starter control circuits to the equipment under Division 23.

.2 Pumps for Domestic Water, Plumbing & Drainage Systems

.1 Provide all 208V and 120V wiring as shown on drawings. Except where specifically noted otherwise, all control for fans is to be supplied, installed and wired from the starter control circuits to the equipment under division 23.

.3 Unit Heaters

.1 Provide power wiring and starter for unit heater fans. Install and wire line voltage thermostats supplied by others. Where thermostats are low voltage or pneumatic, control wiring is under Division 23.

.4 Forced Flow Convectors

.1 Provide 120V power supply to the convectors. Starters, speed controllers and temperature controllers will be supplied and wired by Division 23.

2. Products

2.1 3 PHASE MOTOR DISCONNECT SWITCHES

.1 Industrial Type "A", having quick make, quick break visible blade mechanism, cover interlocks and padlocking switch in the closed or open position. Use EEMAC 4 enclosures outdoors, and EEMAC 1 indoors switches to be H.P. rated, Westinghouse heavy duty type.

2.2 120 VOLT, 1 PHASE DISCONNECT SWITCHED

.1 Manual starter without overload relay.

2.3 600 VOLT, 1 PHASE MOTOR DISCONNECT SWITCHES

.1 Manual starter without overload relay.

3. Execution

3.1 INSTALLATION

.1 Provide disconnect switches adjacent to all motors.

- .2 Provide all wiring between all force flow and unit heaters and their line voltage thermostats. Install wiring between all flow switches and valve monitors.
- .3 Do control wiring as indicated on the drawings and the motor control schedules.
- .4 Connection to motors and ancillary control equipment shall utilize liquid tight flexible metal conduit with adequately sized bonding conductor.
- .5 Division 26 shall wire up all controls where controls switch power lines directly, such as a line voltage thermostat.
- .6 Check phase rotation before energizing.
- .7 Connect up all motorized dampers and backdraft dampers as indicated on mechanical drawings or specified in mechanical specifications.
- .8 Provide relay / contactors as required, operated by built-in motor thermal protection devices (thermistors), for motors incorporating this type of overload protection.
- .9 Provide disconnects for boiler modules (one disconnect per module), and wire up low water cutoffs. Confirm horsepower of boiler burners with mechanical contractor.
- .10 Provide control power supply outlets and data outlets as required by Honeywell for operation of control panels and similar equipment. Allow for a separate circuit for each control panel unless otherwise indicated. Coordinate with Honeywell.
- .11 Provide power to sump pumps and associated control panel. Installation to meet requirements of CEC Section 22 and Inspection Authority.
- .12 Provide 120V connection to infrared sink, urinals & toilets controls. Provide and install GFCI receptacles for multi-station Bradley lavatories in the student washrooms.
- .13 Provide 120V, 15A, single phase circuit to each refrigerated drinking fountain. Coordinate exact location, and whether hard-wired or plug-in, with mechanical contractor.
- .14 Provide a 120V, 15A, single phase circuit for the interior lights on main ventilation unit.
- .15 Provide a 120V, 15A, single phase circuit to each flammable storage cabinet for power vent. Coordinate on site regarding exact location of cabinets and vent fan.
- .16 Provide single connection to dust collector control panel. From control panel wire up dust collector motor and shaker motor individually as per dust collector shop drawings. Interlock to the makeup air unit supply air into the CTS room. Control panel comes complete with necessary starters and control transformers.
- .17 Provide an empty conduit stub from every thermostat and sensor location shown on mechanical drawings, up to ceiling space. Coordinate with Honeywell.
- .18 Coordinate requirements for the foregoing with the mechanical trade.
- .19 Provide a 120V, 15A, single phase circuit to each Kiln Venting system.
- .20 Provide single phase circuit for internal lights on ventilation units.

3.2 VARIABLE FREQUENCY DRIVES

- .1 Loose variable frequency drives (VFDs) will be supplied by Div. 23, to control mechanical equipment requiring speed control. Electrical Contractor shall install VFDs, including all necessary line voltage wiring connections.
- .2 Packed VFDs on pumps will be supplied by the pump supplier.
- .3 VFDs are to be mounted as close the motor as possible.
- .4 Identify mounting requirements and include all materials and labour, including unistrut frames and plywood backboards, as per of this tender, as required to support VFDs if wall space is inadequate. Plywood used on unistrut frames to be minimum 19 mm thick, painted both sides with fire retardant intumescent paint.

- .5 Electrical Contractor should allow for line and load side connections to each VFD, as well as the supply and installation of a disconnect for each motor.

3.3 MOTORIZED ROLLER SHADES

- .1 Motorized roller shades are to be installed complete with controls and limit switches by Section 12 24 13. Run power to a junction box adjacent to each shade and connect up complete with recessed conduit. Install and connect up remote rocker switches. Each shade requires a 120V, 15A, single phase circuit.

3.4 Not used

- .1

3.5 BARRIER FREE DOOR OPERATORS.

- .1 Provide power and control rough in and wiring for motorized doors for barrier free doors.
- .2 Barrier Free door push buttons shall be cabled with 2 pair 22 AWG – Decacom 40-101 (solid wire) or approved equivalent and the exterior door push button station shall be cabled with 2 pair 18 AWG – Decacom 74-316 (solid wire) or approved equivalent.
- .3 Provide a 120V, 15A, single phase circuit to each barrier free door operator motor. Refer to door hardware schedule in Section 08 70 00 and schematics on drawings for more information. See architectural door schedule for quantity and door type.
- .4 Final connections of Barrier Free Door. Push buttons by Barrier Free door supplier. Coordinate with Barrier Free Door Supplier.

END OF SECTION

1. General

1.1 SUMMARY

- .1 Section includes:
 - .1 General specification for the relay lighting control system
 - .2 The Electrical Contractors, as part of the work of this section, shall coordinate, receive, mount, connect and place into operation all equipment. The electrical contractor shall furnish all conduit, wire, connectors, hardware and other incidental items necessary for the complete and properly functioning relay lighting control system as described herein and shown on the plans.
- .2 Related sections:
 - .1 Section [262726 - Wiring Devices]
 - .2 Section [260923 – Lighting Control Devices:] Occupancy sensors used in conjunction with the lighting control system.
 - .3 Section [260943.13 – Digital-Network Lighting Controls:] Lighting control panels

1.2 REFERENCES

- .1 American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE)
 - .1 C62.41-1991 – Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
- .2 ASTM International (ASTM)
 - .1 D4674 -02a Standard Test Method for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Fluorescent Lighting and Window-Filtered Daylight
- .3 Canadian Standards Association (CSA) .
 - .1 CSA C22.2 # 14 Industrial Control Equipment
 - .2 CSA C22.2 # 184 Solid-State Lighting Controls
 - .3 CSA C22.2 # 156 Solid-State Speed Controls
- .4 European Commission (CE) - Harmonized European Standard.
 - .1 IEC/EN 60669-2-1 Switches for household and similar fixed electrical installations - electronic switches.
- .5 International Electrotechnical Commission .
 - .1 (IEC) 801-2 Electrostatic Discharge Testing Standard.
 - .2 IEC/EN 60669-2-1 Switches for household and similar fixed electrical installations - electronic switches.
- .6 International Organization for Standardization (ISO)
 - .1 9001:2000 – Quality Management Systems.
- .7 National Electrical Manufacturers Association (NEMA)
 - .1 WD1 (R2005) - General Color Requirements for Wiring Devices.
- .8 Norma Oficial Mexicana (NOM).

- .1 NOM-003-SCFI Productos eléctricos - Especificaciones de seguridad (Electrical products - Safety Specifications)
- .9 Underwriters Laboratories, Inc. (UL):
 - .1 489 (2002) - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
 - .2 508 (1999) - Standard for Industrial Control Equipment.
 - .3 924 (2003) - Emergency Lighting and Power Equipment

1.3 SYSTEM DESCRIPTION

- .1 Lighting Control System
 - .1 Factory assembled switching panels. [and] [interfaces and modules]
 - .2 Low voltage [wall stations] [and] [control interfaces] [and] [sensors].

1.4 SUBMITTALS

- .1 Submit under provisions of Section [013300.]
- .2 Specification Conformance Document: Indicate whether the submitted equipment either:
 - .1 Meets specification exactly as stated.
 - .2 Meets specification via an alternate means and indicate the specific methodology used.
- .3 Shop Drawings; include:
 - .1 Load schedule indicating actual connected load, load type, and voltage per circuit, circuits and their respective control zones, circuits that are on emergency, and capacity, phase, and corresponding circuit numbers.
 - .2 Schematic of system.
- .4 Product Data: Catalog cut sheets with performance specifications demonstrating compliance with specified requirements.

1.5 QUALITY ASSURANCE

- .1 Energy Management Lighting Control System:
 - .1 Listed by [CE] [CSA] [UL] specifically for the required loads. Provide evidence of compliance upon request.

1.6 PROJECT CONDITIONS

- .1 Do not install equipment until following conditions can be maintained in spaces to receive equipment:
 - .1 Ambient temperature: 0° to 40° C (32° to 104° F).
 - .2 Relative humidity: Maximum 90 percent, non-condensing.

- .3 Lighting control system must be protected from dust during installation.

1.7 WARRANTY

- .1 Provide manufacturer's 3 year parts warranty and a limited 10-year warranty shall be provided on all relay cards. These shall be standard warranties and will be in affect for all installations from the date of invoice.

1.8 MAINTENANCE

- .1 Make ordering of new equipment for expansions, replacements and spare parts available to end user.
- .2 Make new replacement parts available for minimum of ten (10) years from date of manufacture.
- .3 Provide toll free factory direct technical support hotline.
- .4 Provide on-site service support for troubleshooting within 24 hours anywhere in continental United States.
- .5 Offer renewable service contract on yearly basis, to include parts, factory labor and annual training visits. Make service contracts available up to ten (10) years after date of system commissioning.

2. Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturer: Eaton Lighting Systems (Formerly Cooper Controls) – Systems: ControlKeeper
- .2 Eaton Lighting Systems (Formerly Cooper Controls) Catalog Numbers:
 - .1 ControlKeeper Metering [CKM]
 - .2 ControlKeeper Metering with Breakers [CKMB]
 - .3 ControlKeeper TouchScreen [CKT]
 - .4 ControlKeeper 4A [CK4A]
 - .5 ControlKeeper 4 [CK4]
 - .6 ControlKeeper 2 [CK2]
- .3 Substitutions: [Not permitted.] [Under provisions of Division 012500.]
- .4 All proposed substitutions (clearly delineated as such) must be submitted in writing for approval by the design professional a minimum of 10 working days prior to the bid date and must be made available to all bidders. Proposed substitutes must be accompanied by a review of the specification noting compliance on a line-by-line basis.
- .5 Any substitutions provided by the contractor shall be reviewed at the contractor's expense by the PCA Departmental Representative at a rate of [\$200.00] per hour.

- .6 By using pre-approved substitutions, the contractor accepts responsibility and associated costs for all required modifications to circuitry, devices and wiring. The contractor shall provide complete engineered shop drawings (including power wiring) with deviations for the original design highlighted in an alternate color to the engineer for review and approval prior to rough-in.

2.2 GENERAL

- .1 Provide hardware that is designed, tested, manufactured and warranted by a single manufacturer.
- .2 Lighting Controls: Ten-year operational life while operating continually at any temperature in an ambient temperature range of 0° C (32°F) to 40° C (104°F) and 90 percent non-condensing relative humidity.
- .3 Designed and tested to withstand electrostatic discharges up to 15,000 V without impairment per IEC 801-2.

2.3 PANEL / RELAY PERFORMANCE REQUIREMENTS

- .1 Electrolytic capacitors to operate at least 20° C below the component manufacturer's maximum temperature rating when device is under fully-loaded conditions in 40° C (104° F) ambient temperature.
- .2 Capable of withstanding repetitive inrush current of 50 times operating current without impacting lifetime of dimmer/relay.
- .3 Design and test relays to withstand line-side surges without impairment to performance.
 - .1 Panels: Withstand surges without impairment of performance when subjected to surges of 6,000 volts, 3,000 amps per ANSI/IEEE C62.41B.
- .4 Utilize air gap off, activated when user selects "off" at any control to disconnect the load from line supply.
- .5 Possess power failure memory such that if power is interrupted and subsequently returned, lights will automatically return to same levels (on or off) prior to power interruption within 3 seconds.
- .6 Non-dim circuits to meet the following requirements:
 - .1 Rated life of relay: Minimum 1,000,000 cycles.
 - .2 Load switched in manner that prevents arcing at mechanical contacts when power is applied to load circuits.
 - .3 Fully rated output continuous duty for inductive, capacitive and resistive loads.
- .7 Capable of controlling receptacle or plug loads with Latching Relay Option.
- .8 Power Metering Relay Cards to be used with the ControlKeeper Metering lighting panels CKMB.
 - .1 Individually Replaceable
 - .2 Minimum UL listed Short Circuit Current Rating (SCCR) of 65,000A.
 - .3 Rated life of relay: Minimum 1,000,000 cycles.

- .4 Load switched in manner that prevents arcing at mechanical contacts when power is applied to load circuits.
 - .5 Fully rated output continuous duty for inductive, capacitive and resistive loads.
 - .6 Capable of controlling receptacle or plug loads. PM-LRC
 - .7 Eaton Lighting Systems (Formerly Cooper Controls) Catalog Numbers: PM-SRC, PM-TPRC, PM-LRC
- .9 Serial Latching Relay Card to be used with the ControlKeeper lighting panels CKT, CK4A.
- .1 Rated life of relay: Minimum 1,000,000 cycles.
 - .2 Four 20amp relays at 120/277/347VAC
 - .3 Manual Override per relay
 - .4 Accepts up to 6 AWG wire
 - .5 Load switched in manner that prevents arcing at mechanical contacts when power is applied to load circuits.
 - .6 Fully rated output continuous duty for inductive, capacitive and resistive loads.
 - .7 Capable of controlling receptacle or plug loads.
 - .8 Eaton Lighting Systems (Formerly Cooper Controls) Catalog Numbers: sLRC
- .10 Serial Standard Relay Card to be used with the ControlKeeper lighting panels CKT, CK4A.
- .1 Rated life of relay: Minimum 1,000,000 cycles.
 - .2 Four 20amp relays at 120/277VAC
 - .3 Manual Override per relay
 - .4 Accepts up to 10 AWG wire
 - .5 Load switched in manner that prevents arcing at mechanical contacts when power is applied to load circuits.
 - .6 Fully rated output continuous duty for inductive, capacitive and resistive loads.
 - .7 Eaton Lighting Systems (Formerly Cooper Controls) Catalog Numbers: sSRC-NO
- .11 Serial Two Pole Relay Card to be used with the ControlKeeper lighting panels CKT,CK4A.
- .1 Rated life of relay: Minimum 1,000,000 cycles.
 - .2 Two 20amp relays at 208/240/480VAC (two pole)
 - .3 Manual Override per relay
 - .4 Accepts up to 6 AWG wire
 - .5 Load switched in manner that prevents arcing at mechanical contacts when power is applied to load circuits.
 - .6 Fully rated output continuous duty for inductive, capacitive, and resistive loads.
 - .7 Eaton Lighting Systems (Formerly Cooper Controls) Catalog Numbers: sTPRC-NO

2.4 POWER PANELS

- .1 Product: Eaton Lighting Systems (Formerly Cooper Controls) ControlKeeper Relay Panel with Breakers CKMB
- .2 Mechanical:
 - .1 Listed to ULC listed as industrial control equipment.
 - .2 Delivered and installed as a CSA listed factory assembled panel.

-
- .3 Field wiring accessible from front of panel without need to remove relay assemblies or other components.
 - .4 Panels passively cooled via free-convection, unaided by fans or other means.
 - .5 All panels include individual relay override and status LED as well as a Master Override switch. This allows the relays to be individually controlled without using the circuit breaker.
 - .6 [Surface mounted].
 - .3 Electrical:
 - .1 Panels contain branch circuit protection for each circuit unless the panel is a dedicated feed-through type panel or otherwise indicated on the drawings.
 - .2 Branch circuit breakers; meet following performance requirements:
 - .1 Listed to UL 489 as molded case circuit breaker for use on lighting circuits.
 - .2 Contain visual trip indicator; rated at up to 25,000 AIC.
 - .3 Thermal-magnetic construction for overload, short circuit and over-temperature protection. Use of breakers without thermal protection requires dimmers/relays to have integral thermal protection to prevent failures when overloaded or ambient temperature is above rating of panel.
 - .4 Accept tag-out/lock-out devices to secure circuit breakers in off position when servicing loads.
 - .5 Replaceable without moving or replacing relay assemblies or other components in panel.
 - .6 UL listed as switch duty (SWD) so that loads can be switched on and off by breakers.
 - .3 Minimum UL listed Short Circuit Current Rating (SCCR) of 65,000A.
 - .4 Rated life of relay: Minimum 1,000,000 cycles.
 - .5 Load switched in manner that prevents arcing at mechanical contacts when power is applied to load circuits.
 - .6 Fully rated output continuous duty for inductive, capacitive and resistive loads.
 - .4 TouchScreen Panel Processor
 - .1 Language selection: English
 - .2 Integral contact closure inputs.
 - .3 Integral 0-10V analog inputs
 - .4 Integral digital switch port
 - .5 Integral Serial Communication Port
 - .6 Integral USB Communication Port
 - .7 Integral Ethernet Communication Port
 - .8 Programming and system operation:
 - .1 Digital Switches, Network Commands and contact closure inputs
 - .1 Assign functionality of each input
 - .1 Select Relays or Groups of Relays
 - .2 Independent On/Off command functions (On/ Off/ No Command)
 - .3 Independent priorities per command (up to sixteen priority levels)
 - .4 Sixteen Mask features per panel
 - .1 Masking features include No On, No Off, Ignore, Reevaluate, No Timer based on time schedules and day of week programming.

- .5 Up to 999 minute timer
 - .6 Ability to issue and cancel Warn Off events
 - .2 Serial interface or Ethernet interface
 - .1 Communications protocol provided at no charge
 - .2 Any lighting panel can be monitored, programmed or controlled from any RS-232 or Ethernet connection
 - .3 Network Commands
 - .1 Any input can be programmed to broadcast its state or reading to the lighting control network
 - .2 Any input can be programmed as a Network Listener to receive state or reading from a broadcasted input.
 - .4 Contact closure output: Momentary, Maintained, Toggle
 - .1 Select Relays or Groups of Relays
 - .2 Independent On/Off command functions (On/ Off/ No Command)
 - .3 Independent priorities per command (up to sixteen priority levels)
 - .4 Sixteen Mask features per panel
 - .1 Masking features include No On, No Off, Ignore, Reevaluate, No Timer based on time schedules and day of week programming.
 - .5 Up to 999 minute timer
 - .6 Ability to issue and cancel Warn Off events
 - .2 Time clock
 - .1 Integral astronomical time clock
 - .1 Geographic location (city or latitude/longitude).
 - .2 Adjustable astronomic Offset (+) or (-)
 - .3 Adjustable date and time format.
 - .4 Adjustable starting and ending of daylight savings time.
 - .5 Selectable day of week time event programming
 - .6 Select Relays or Groups of Relays
 - .7 Independent On/Off command functions (On/ Off/ No Command)
 - .8 Independent priorities per command (up to sixteen priority levels)
 - .9 Review and modify time clock schedule to add, copy, modify and delete events.
- .5 Diagnostics and Service:
 - .1 Replacing relay does not require re-programming of system or processor.
 - .2 Relays: Include diagnostic LED's to verify proper operation and assist in system troubleshooting.
 - .3 Relay panels: Include tiered control scheme for dealing with component failure that minimizes loss of control for occupant.
 - .1 Failures on the lighting control system network are localized to the failed product. All other lighting control panels continue to fully function without Additionalaction. Systems that have a single point of failure on the network shall not be acceptable.
 - .4 If lighting control system fails, lights to remain at current level. Individual relay overrides provides local control of lights until system is repaired. Each lighting

control panel include a master override to override the entire lighting panel.

- .6 Real Time Energy Meter per circuit
 - .1 Real Time Energy Metering data shall be supported via integral power metering circuitry on certain ControlKeeper Lighting Panels. [CKM], [CMKB]
 - .1 Electrical device to provide real time power metering of voltage and current shall be provided with each relay.
 - .2 Metered data can be polled via public command string from the on board Ethernet input.
 - .3 Metered data shall be reported based on actual connected relay load.

2.5 LOW VOLTAGE WALL STATIONS

- .1 Product: Greengate Digital Switch white.
- .2 Electronics:
 - 1. Use Eaton Lighting Systems (Formerly Cooper Controls) LCCP or LCCNP wire for low voltage communication wiring for the Greengate Digital Switch.
 - 2. Use 18 AWG wire for low voltage dry contact switches. Number of conducts is based on type of switch.
- .3 Functionality:
 - .1 Upon button press, LEDs to immediately illuminate.
 - .2 LEDs to reflect the true system status. LED state is programmable to reflect either relay state or button push state.
 - .3 Allow for easy reprogramming without replacing unit.
 - .4 Replacement of units does not require reprogramming.
- .4 Provide faceplates with Low Voltage Wall Stations
- .5 Engrave wall stations with appropriate button, zone and scene engraving descriptions furnished prior to fabrication.

2.6 LOW VOLTAGE CONTROL INTERFACES

- .1 Contact Closure
 - .1 Integral contact closures to accept both momentary and maintained contact closures.
 - .2 Systems that do not include integral contact closures shall not be acceptable.
- .2 Serial Interface
 - .1 Provide ability to communicate by means of serial communication by means of user-supplied PC or digital audiovisual equipment. Control to be located within 50 feet (15 meters) of source.
 - .2 Communications protocol to provide access to:
 - .1 Individual Relay Commands
 - .2 Individual Relay Status
 - .3 Input Status
 - .4 Network Override Commands
 - .3 Provide full programming, monitoring and override control using Keeper Enterprise Programming software.

- .3 Ethernet Interfaces; Eaton Lighting Systems (Formerly Cooper Controls) Model Ethernet Interface Module
 - .1 Provide ability to communicate by means of TCP/IP over Ethernet to ControlKeeper lighting control system by means of user-supplied PC or digital audiovisual equipment. Control to be located within 300 feet (100 meters) of Ethernet source.
 - .2 Communications protocol to provide access to:
 - .1 Individual Relay Commands
 - .2 Individual Relay Status
 - .3 Input Status
 - .4 Network Override Commands
 - .3 (Optional) Provide full programming, monitoring and override control using Keeper Enterprise Programming software.
 - .4 (Optional) The lighting zones may be controlled through a graphical representation software package called VisionTouch®. The software permits up to 255 floors or site plans to be illustrated for intuitive control. The software provides real-time feedback to the operator of network control overrides and relay status.
 - .5 (Optional) The lighting zones may be controlled through a graphical representation of four switches on multiple PC's that are connected to the building LAN. This software package for lighting control overrides is called VisionSwitch®. The software permits unlimited users connected to the building LAN to control their lighting zones. The software provides immediate feedback to the operator/user of network control overrides.
 - .6 (Optional) The lighting zones may be controlled using standard calendar based scheduling software. Create events which include individual and groups of relays and link them to any time and day on the calendar. This software package for lighting control event scheduling is called Event Manager. This software requires a SQL Server for operation connected to the lighting control system via the Ethernet Interface Module.
- .4 BACnet Interface; Eaton Lighting Systems (Formerly Cooper Controls) Model AIM B NW:
 - .1 The ControlKeeper® network shall permit data protocol translation through a building automation interface Gateway. The BACnet Gateway shall permit BACnet communication protocol to operate individual relays, relay groups and read the status of those relays. The ControlKeeper® network shall respond efficiently to the requested information from the BACnet network.
 - .2 Provide PIC list definition and object model to other system manufacturers.
- .5 LonWorks Interface; Eaton Lighting Systems (Formerly Cooper Controls) Model AIM L NW:
 - .1 Provide ability to communicate by means of LonWorks FTT-10 communication to centralized lighting system from user-supplied LonWorks FTT-10 twisted pair network.
 - .2 The ControlKeeper® network shall permit data protocol translation through a building automation interface Gateway. The LON Gateway shall permit LonWorks communication protocol to operate individual relays, relay groups and read the status of those relays. The ControlKeeper® network shall respond efficiently to the requested information from the LonWorks network.
 - .3 Provide LonWorks interface object model specification to secondary equipment manufacturers.
- .6 Emergency Lighting Interface; Eaton Lighting Systems (Formerly Cooper Controls) Model LRM120
 - .1 Provides total system listing to UL 924 when used with ControlKeeper system.

- .2 Senses the loss of normal power.
- .3 Provides an output to override the ControlKeeper lighting panels to the all On state.

2.7 SENSORS

- .1 Refer Section 260923 – Lighting Control Devices and drawings: Occupancy sensors used in conjunction with the lighting control system.
- .2 Exterior Daylight Sensors:
 - .1 Calibrated with independent turn-on and turn-off thresholds; minimum 2 foot-candles difference between the turn-on and turn-off thresholds.
 - .2 Enclosed in weatherproof housing with shading and lens protection visor.

2.8 OPEN ADR VIRTUAL END NODE (VEN) FOR DEMAND RESPONSE

- .1 The ControlKeeper shall be capable of receiving a signal from a Demand Response or OpenADR Virtual End Node device. When received the ControlKeeper will automatically adjust lighting to provide optimal energy savings and comply with Demand Response code requirements. Systems that do not support Demand Response capability shall not be acceptable.
 - .1 Automatically adjust the target lighting level by at least 15% but not more than 50%.
 - .2 System does not permit user override of the Demand Response system except in the cases of emergency or normal power loss. Systems that allow the user to adjust the lights higher than the demand response target light level shall not be acceptable.
 - .3 Each ControlKeeper shall be configurable for individual Demand Response reduction levels. Systems that only support global Demand Response reduction levels shall not be acceptable.
- .2 Eaton Lighting Systems (Formerly Cooper Controls) Catalog Number:
 - .1 EBOX-2B-DC

2.9 EMERGENCY LIGHTING

- .1 Emergency Power Control – A UL 924 listed device installs down line of an output that monitors a switched or dimmed circuit providing normal lighting to an area. The unit provides normal ON/OFF or 0-10V dimming control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:
 - .1 120/208 volts, 50/60 Hz, 20 amp ballast rating.
 - .2 Push to test button.
 - .3 Eaton Lighting Systems (Formerly Cooper Controls) Catalog Numbers:
 - .1 CEPC-1 (switching)
 - .2 CEPC-1-D (0-10V dimming)

2.10 ACCESSORIES

- .1 The ControlKeeper® has several hardware accessories that may be utilized to enhance your lighting control application. Select from the network hardware accessories which accessories will be utilized for your application.

-
- .1 ControlKeeper® TouchScreen (CKT)
 - .1 The CKT shall provide additional flexibility by providing up to 48 - 20 amp @ 277 VAC rated relays that are addressable and fully programmable from the network. The relay wire terminations shall be able to accept 10 AWG. The CKT controllers, although accessible through the network, shall be fully stand-alone in their control capability. The CKT provides full status indication of CPU status, network communication, power, and HOA overrides. The controller shall provide thirty-two, 3-wire or 2-wire dry contact inputs that may be configured as maintained or momentary inputs. The controller shall provide four analog inputs. The controller shall provide up to 64 digital buttons for overrides. The controller shall provide 128 additional global commands for network control and shall reside in the CKT. Networks that rely on a single time clock for system operation shall not be acceptable.
 - .2 ControlKeeper® 4A (CK 4A)
 - .1 The CK 4A shall provide additional flexibility by providing four 20 amp @ 277 VAC rated relays that are addressable and fully programmable from the network. The relay wire terminations shall be able to accept 10 AWG. The CK 4A shall optionally provide four, 0-10VDC outputs to control dimming ballasts. The CK 4A controllers although accessible through the network shall be fully stand-alone in their control capability. The CK 4A provides full status indication of CPU status, network communication, power and HOA overrides. The controller shall provide four, 3-wire or eight, 2-wire dry contact inputs that may be configured as maintained or momentary inputs. The controller shall provide four analog inputs. The controller shall provide up to 64 digital buttons for overrides. The controller shall provide 64 additional global commands for network control and shall reside in the CK 4A. Networks that rely on a single time clock for system operation shall not be acceptable.
 - .3 ControlKeeper® 4 (CK 4)
 - .1 The CK 4 shall provide additional flexibility by providing four normally open or normally closed 20 amp @ 277 VAC rated relays that are addressable and fully programmable from the network. The relay wire terminations shall be able to accept 10 AWG. The CK 4 controllers although accessible through the network shall be fully stand-alone in their control capability. The CK 4 provides full status indication of CPU status, network communication, power and HOA overrides. The controller shall provide four dry contact inputs that may be configured as maintained or momentary inputs. The controller shall provide up to 64 digital buttons for overrides. The controller shall provide 64 additional global commands for network control and shall reside in the CK 4. Systems that utilize the master slave topology shall not be acceptable.
 - .4 ControlKeeper® 2 (CK 2)
 - .1 The CK 2 shall provide additional flexibility by providing two normally open or normally closed 20 amp @ 277 VAC rated relays that are addressable and fully programmable from the network. The relay wire terminations shall be able to accept 10 AWG. The CK 2 controllers although accessible through the network shall be fully stand-alone in their control capability. The CK 2 provides full status indication of CPU status, network communication, power, and HOA overrides. The controller shall provide two dry contact inputs that may be configured as maintained or momentary inputs. The controller shall provide up to 64 digital buttons for overrides. The controller shall provide 64 additional global commands for network control and shall reside in the CK 2. Systems that utilize the master slave topology shall not be acceptable.

2.11 SOURCE QUALITY CONTROL

- .1 Perform full-function testing on completed assemblies at end of line. Statistical sampling is not acceptable.

3. EXECUTION

3.1 EQUIPMENT INSTALLATION AND DOCUMENTATION

.1 Installation

The control system shall be installed and fully wired as shown on the plans by the installing contractor. The contractor shall complete all electrical connections to all control circuits and override wiring.

.2 Documentation

The contractor shall provide accurate "as-built" drawings to the owner for correct programming and proper maintenance of the control system. The "as-builts" shall indicate the load controlled by each relay and the relay panel number.

.3 Operation and Service Manuals

The factory shall supply all operation and service manuals.

3.2 PRODUCT SUPPORT AND SERVICE

.1 Factory Support

Factory telephone support shall be available at no cost to the owner. Factory assistance shall consist of solving programming or application questions concerning the control equipment.

3.3 SYSTEM DELIVERY AND ACCEPTANCE

.1 Delivery

The contractor is responsible for complete installation of the entire system according to strict factory standards and requirements. The following items shall constitute factory standards and requirements:

- .1 All system equipment shall operate in accordance with specification and industrial standard procedures.
- .2 An operational user program shall exist in the control system. The program shall execute and perform all functions required to effectively operate the site according to the requirements.
- .3 Demonstration of program integrity during normal operation and pursuant to a power outage.
- .4 Contractor shall provide a minimum of two training hours on the operation and use of the control system. Additional support services shall be negotiated between the contractor and the building owner or manager.

3.4 FACTORY COMMISSIONING (OPTIONAL)

- .1 Upon completion of the installation, the system shall be commissioned by the manufacturer's factory authorized representative who will verify a complete fully functional system.

- .2 The electrical contractor shall provide both the manufacturer and the PCA Departmental Representative with twenty one working days written notice of the system startup and adjustment date.
- .3 Upon completion of the system commissioning the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system.

3.5 WARRANTY

- .1 Warranty

Manufacturer shall supply a 3-year warranty on all hardware and software. A limited 10-year warranty shall be provided on all relay cards. These warranties will be in affect for all installations. Systems that provide special warranties based on installation shall not be acceptable.

END OF SECTION

1. General

1.1 RELATED SECTIONS

- .1 Section 26 09 23 Low Voltage Switching.

1.2 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 26 05 01.
- .2 Data to indicate system components, mounting method, source of power and special attachments.
- .3 Supplier shall substantiate conformance to this specification by supplying the necessary documents, performance data and wiring diagrams. Any deviations to this specification must be clearly stated by letter and submitted.
- .4 After award of tender, the Owner shall supply to the occupancy sensor supplier drawings showing the proposed location and type of all occupancy sensors. The supplier shall submit this lighting plan, clearly marked showing proper product, location and orientation of each sensor.
- .5 Submit any interconnection diagrams per major subsystem showing proper wiring.
- .6 Submit standard catalog literature that includes performance specifications indicating compliance to the specification.
- .7 Catalog sheets must clearly state any load restrictions when used with electronic ballasts.
- .8 At conclusion of commissioning period, supplier shall provide a spreadsheet listing the final setting of each parameter (sensitivity, time delay, orientation) of each sensor.

1.3 WORK INCLUDED

- .1 Supplier's scope of work to include all materials, appliances, control hardware, sensors, swivel mounting brackets, and equipment necessary for and incidental to the delivery and commissioning of a completely operational occupancy sensor lighting control system, as described herein. This contractor shall provide all labour, tools, wire, junction boxes, and equipment necessary for and incidental to the installation of the system.
- .2 Supplier shall examine all specification provisions and drawings for related electrical work required as work under Division 26. System shall be fully compatible with low voltage switching system in Section 26 09 23.
- .3 This contractor shall coordinate all work described in this section with all other applicable plans and specifications, including but not limited to wiring, conduit, fixtures, HVAC systems and building management systems except as otherwise specified.

1.4 EQUIPMENT QUALIFICATION

- .1 Products supplied shall be from a single supplier that have been continuously involved in manufacturing of occupancy sensors. Mixing of suppliers shall not be allowed.
- .2 All components shall be CSA or CUL certified, and meet all applicable code requirements.

- .3 Wall switch products must be capable of withstanding the effects of inrush current. Submittals shall clearly indicate the method used.

1.5 SYSTEM DESCRIPTION

- .1 The objective of this section is to ensure the proper installation of the occupancy sensor based lighting control system so that lighting is turned off automatically after reasonable time delay when a room or area is vacated by the last person to occupy said room or area.
- .2 The occupancy sensor based lighting control shall accommodate all conditions of space utilization and all irregular work hours and habits.
- .3 Occupancy sensor shall work in cases where the light fixtures are eight line voltage switched or where they are low voltage switched.
- .4 Supplier shall warrant to this contractor all equipment furnished in accordance to this specification to be undamaged, free of defects in materials and workmanship, and in conformance with specifications for a period of five (5) years. The supplier's obligation shall include repair or replacement, and testing without charge to the Owner, all or any parts of equipment which are found to be damaged, defective or non-conforming and returned to the supplier. The warranty shall commence upon the Owner's acceptance of the project.

2. Products

2.1 COMPONENT REQUIREMENTS

- .1 Wall switch sensors shall be capable of detection of occupancy at desktop level up to 30 m², and gross motion up to 100 m².
- .2 Wall switch sensors shall accommodate loads from 0 to 800 W at 120V; 0 to 1500 W at 120V and shall have 180° coverage capability with adjustable internal shutters to reduce coverage.
- .3 Wall switch products shall utilize zero crossing circuitry which increases relay life, protects from the effects of inrush current and increase sensor's longevity.
- .4 Wall switch sensors shall have no leakage current to load, in manual or in Auto / Off mode for safety purposes and shall have voltage drop protection.
- .5 Wall switch sensors shall provide a field selectable option to convert sensor operation from automatic-ON to manual-ON.
- .6 Where specified, vandal resistant wall switch sensors shall utilize a hard lens with a minimum 1.0mm thickness. Product utilizing a soft lens will not be considered.
- .7 Passive infrared sensors shall utilize pulse count processing and digital signature analysis to respond only to those signals caused by human motion.
- .8 Passive infrared sensors shall provide high immunity to false triggering from RFI (hand-held radios) and EMI (electrical noise on the line).
- .9 Passive infrared sensors shall have a multiple segmented Fresnel lens, in a multiple-tier configuration, which grooves in to eliminate dust and residue build-up.

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- .10 Daylighting control shall be accomplished by separate photo sensors and daylight sensors. Photo sensors are described under section 26 06 24 for relay controlled lights. Daylight sensor to be single zone, on / off switching type, automatic calibrations, easy to read LCD display & LED status. Allow for onsite calibration by Electrical Contractor.
 - .11 Dual technology sensors shall be either corner mounted or ceiling mounted in such a way as to minimize coverage in unwanted areas. Wiring shall be brought from the ceiling in either case.
 - .12 Dual technology sensors shall consist of passive infrared and ultrasonic technologies for occupancy detection. Products that react to noise or ambient sound shall not be considered.
 - .13 Ultrasonic sensors shall utilize advanced signal processing to adjust the detection threshold dynamically to compensate for constantly changing levels of acidity and air flow throughout controlled space.
 - .14 Ultrasonic operating frequency shall be crystal controlled at nominally 40 kHz within $\pm 0.002\%$ tolerance to assure reliable performance and eliminate sensor cross-talk. Sensors using multiple frequencies are not acceptable.
 - .15 Sensors that cause interference with patients using cochlear implants or hearing aids are not acceptable and will be replaced by suitable project within the five (5) year warranty period at the supplier's expenses.
 - .16 All sensors shall be capable of operating normally with electronic ballasts, LED drivers compact fluorescent lamp system and rated motor loads.
 - .17 Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioner or heating fans.
 - .18 Sensors shall utilize technology for automatically adjustable time delay and sensitivity settings.
 - .19 All sensors shall have readily accessible, user adjustable settings for time delay and sensitivity. Settings shall be located on the sensor (not the control unit) and shall be recessed to limit tampering.
 - .20 In the event of failure, a bypass manual override shall be provided on each sensor. When bypass is utilized, lighting shall remain on constantly or control shall divert to a wall switch until sensor is replaced. This control shall be recessed to prevent tampering.
 - .21 All sensors shall provide an LED as a visual means of indication at all times to verify that motion is being detected during both testing and normal operation.
 - .22 Sensor shall have an internal additional isolated relay with Normally Open, Normally Closed and Common outputs for use with HVAC control, Data Logging and other control options. Sensors utilizing separate components or specially modified units to achieve this function are not acceptable.
 - .23 All sensors shall have UL rated, plastic enclosures, white finish.
 - .24 All sensors shall have auxiliary contacts.

2.2 CIRCUIT CONTROL HARDWARE

- .1 Control units (power packs and auxiliary relay or slave packs): for ease of mounting, installation and future service, control unit(s) shall be able to externally mount through at 16 mm knock-out on a standard electrical enclosure and be an integrated, self-contained unit consisting internally of an isolated load switching control relay and a transformer (except slave packs) to provide low-voltage power. Control unit provide power to a minimum of two (2) sensors.
- .2 Relay contacts shall have ratings of 3A – 120 Vac tungsten, 20A – 120 Vac ballasted.
- .3 Control wiring between sensors and controls units shall be Class II, No. 18-24 AWG, stranded CSA certified, PVC insulated or TEFLON jacketed cable suitable for use to plenums, FT-4 or CMR rated.
- .4 Minimum acceptable wire gauge from the circuit control hardware relays shall be #214 AWG.

2.3 ACCEPTABLE MANUFACTURERS

- .1 Refer to table below for applicable sensor types. Actual sensor type and location within the room shall be recommended by the supplier. All catalog numbers below refer to project manufactured by The Watt Stopper Inc. All sensors are to be suitable for mounting to outlet boxes. Acceptable manufacturers are Leviton and sensor switch.

- .2 Ceiling sensors:

Type	Technology	Coverage Area (at 80%)	Standard of Acceptance
C1	Ultrasonic	45 m ²	WT-600
C2	Ultrasonic	85 m ²	WT-1100
C3	Passive Infrared	37 m ²	C-200-1
C4	Dual Technology	74 m ²	DT-300
C5	Ultrasonic	19 lineal m	WT-2250
C6	Passive Infrared	22 m ²	WPIR
C7	Passive Infrared	150 m ²	CX-100

- .3 Control Unit:

- .1 Power Packs: Power supplied from low voltage lighting control system. Locate power packs near occupancy sensors as recommended by manufacturer.

3. Execution

3.1 INSTALLATION

- .1 The supplier shall recommend prior to rough-in any changes to quantity or location of sensors in order to adequately provide coverage for the room. It shall be this contractor's responsibility to locate and aim sensors in the correct location required for complete and proper volumetric within the range of coverage(s) of controlled areas per the supplier's recommendations.
- .2 Rooms shall have ninety (90) to one hundred (100) percent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants

at any location within the room(s). The locations and quantities of sensors shown on the drawings are diagrammatic and indicate the rooms which are to be provided with sensors.

- .3 It is the supplier's responsibility to arrange for supplier's factory authorized representative to attend pre-installation meetings at the project site, to verify placement of sensors and installation criteria prior to rough-in.
- .4 Proper judgment must be exercised in executing the installation so as to ensure the best possible installation in the available space to overcome local difficulties due to space limitations or interference of structural components. The supplied shall also provide, at the Owner's facility, the training necessary to familiarize the Owner's personnel with the operation, use, adjustment, and problem solving diagnosis of the occupancy sensing devices and systems.
- .5 All sensors shall initially be set to a 15 minute time delay user adjustable from 1 s to 30 min), except where otherwise noted on the drawings.
- .6 Sequence of operation shall be as follows: When motion is detected, the occupancy sensor starts its time-out timer and sends an ON signal to the relay scanner to activate associated relays, and also enables the daylight sensors, and turn the light on. Whenever motion is again detected, the time-out timer is reset to zero time. The time-out timer only expires when no motion has occurred during a time equal to the time-out setting. Upon time-out expiry, the occupancy sensor sends an OFF signal to the relay scanner and disables the daylight sensors, and turns the lights off.

3.2 COMMISSIONING

- .1 Upon completion of the installation, in conjunction with the Contractor and the Owner, the entire system shall be completely commissioned by the supplier's factory authorized technician. This team will verify all adjustments and sensor placements to ensure a trouble-free occupancy-based lighting control system

END OF SECTION

1. General

1.1 SECTION INCLUDES

- .1 Low Voltage Switchboard – Furnish and install switchboard(s) as specified herein and where shown on the associated schedules and drawings.

1.2 REFERENCES

- .1 The switchboard(s) and overcurrent protection device(s) referenced herein are designed and manufactured according to the latest revision of the following specifications.
 - .1 Switchgear assemblies: CSA C22.2 No.31
 - .2 UL891
 - .3 Panelboards: CSA C22.2 No.29
 - .4 Molded Case Circuit Breakers: CSA C22.2 No. 5
 - .5 UL489
 - .6 Enclosed Switches: CSA C22.2 No. 4

1.3 SUBMITTAL AND RECORD DOCUMENTATION

- .1 Approval documents shall include drawings. Drawings shall indicate front and side enclosure elevations with overall dimensions shown; conduit entrance location and requirements, single-line diagrams, equipment schedule and switchboard instrument details.

1.4 QUALIFICATIONS

- .1 Company specializing in manufacturing of switchboard products
- .2 Switchboards shall be manufactured in accordance with standards listed Article 1.02 – REFERENCES.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Inspect and report concealed damage to carrier within their required time period.
- .2 Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.
- .3 Store in a clean, dry environment. Maintain factory packaging and, if required, provide an additional heavy canvas or heavy plastic cover to protect enclosure(s) from dirt, water, construction debris, and traffic.

1.6 OPERATIONS AND MAINTENANCE MATERIALS

- .1 Manufacturer shall provide installation instructions:
 - Instructions for Safe Installation, Operation and Maintenance of Switchboards Rated 600 Volts or less.

1.7 WARRANTY

- .1 Manufacturer shall warrant specified equipment free from defects in materials and workmanship for the lesser of one (1) year from the date of installation or eighteen (18) months from the date of purchase.

1.8 RELATED SPECIFICATIONS

- .1 Section 260526 – Grounding and Bonding
- .2 Section 261313 – Enclosed Circuit Breakers
- .3 Section 262313 – Enclosed Switches
- .4 Section 262416 – Panelboards
- .5 Section 264300 – Surge Protective Device (SPD)
- .6 Section 262300 – Low-Voltage Switchgear
- .7 Section 26091380 – Web Enabled Power Distribution
- .8 Section 26091310 – Electrical Power Monitoring and Control

2. Products

2.1 MANUFACTURERS

- .1 Shall be Square D Company
- .2 Substitutions must be submitted in writing three weeks prior to original bid date with supporting documentation demonstrating that the alternate manufacturer meets all aspects of the specification herein.

2.2 TERMINATIONS

- .1 Termination lugs shall be CSA/UL Listed to accept solid or stranded [copper and aluminum conductors] [copper conductors only]. Termination lugs shall be suitable for cables sized per the 75C column of the CE Code table. It is permissible for primary cables terminating in a bussed auxiliary section to be sized to the 90C column of the CE Code.

2.3 ENCLOSURE

- .1 The switchboard shall be totally enclosed, dead front, freestanding or freestanding wall supported, and rear aligned with front, side or rear access.
- .2 The switchboard shall be NEMA Type 1 – with drip hood.
- .3 NEMA Type 1 enclosure shall be Sprinkler Protection CEC26-008.
- .4 The framework shall be formed steel and secured together to support all cover plates, bussing and component devices during shipment and installation. All closure plates are to be single tool, screw removable. Ventilation shall be provided when required. Each section shall include a single-piece removable top plate.
- .5 The switchboard enclosure shall be painted on all exterior surfaces. The paint finish shall be ASA49 grey unless otherwise specified.
- .6 Steel base channels shall be bolted to the frame to rigidly support the entire shipping section for moving on rollers and for floor mounting. An option of a steel base channel shall be made available

2.4 BUSSING

- .1 The switchboard shall be high conductivity solid silver-plated copper bus.
- .2 The through bus shall have a maximum ampacity of 400A, 600A, 800A, 1,000A, 1200A, 1600A. The switchboard bussing shall be of sufficient cross-sectional area to meet the CSA C22.2 No. 31 standard for temperature rise.
- .3 The switchboard shall be rated with a minimum short circuit rating of 50,000A at 208Vac.
- .4 Provisions shall be made for future splicing of additional sections.
- .5 All bolts used on bus bar joints shall be a minimum of grade 5.
- .6 The utility metering compartment shall have provisions for window type/bar type current transformers as supplied by the applicable public utility.

2.5 MAIN DISCONNECT DEVICES

- .1 Main Circuit Breaker
 - .1 Electronic trip molded case, full function, circuit breaker
 - .1 Shall be rated for 80% continuous current and be PowerPact P or R style breaker with MICROLOGIC trip system.
 - .2 Shall be rated for 100% continuous current and be PowerPact P or R style breaker with MICROLOGIC trip system.
 - .3 Rated ampacity shall be 1000A, 1200A, 1600A See drawings.
 - .2 Thermal magnetic molded case circuit breaker
 - .1 Shall be rated for 80% continuous current and be PowerPact M, P or R style breaker with standard electronic trip system.
 - .2 Rated ampacity shall be 1000A, 1200A, 1600A See drawings.
 - .1 Stored energy electronic trip insulated case circuit breaker
 - .2 Shall be a MASTERPACT NW, two-step stored energy circuit breaker.
 - .3 Rated ampacity shall be 1000A, 1200A, 1600A See drawings
 - .4 Circuit breaker(s) shall have 10kA, 14kA, 18kA 25kA 35kA 42kA 50kA 65kA interrupting capacity at 208Vac. See drawings.
 - .5 Shall be rated for 100% continuous current.
 - .6 Provide a fixed instantaneous (High Level Selective Override) circuit on breaker(s). The circuit shall have a defeatable instantaneous adjustment to allow the breaker to remain closed for up to 30 cycles during overcurrents below the rms symmetrical short time withstand ratings. The circuit shall instantaneously trip when current levels exceed applicable withstand ratings.
 - .7 Electronic Trip System

- .1 Circuit breaker trip system shall be a **MICROLOGIC** electronic trip unit.
- .2 All trip units shall be removable to allow for field upgrades.
- .3 Trip Units shall incorporate "True RMS Sensing" and have LED long-time pickup indications.
- .4 **MICROLOGIC** trip unit functions shall consist of adjustable long-time pickup and delay, [optional short-time pickup and delay], instantaneous [optional neutral protection and optional ground-fault pickup and delay].
- .5 Adjustable long-time pickup (I_r) and delay shall be available in an adjustable rating plug that is UL Listed as field-replaceable. Adjustable rating plug shall allow for nine long-time pickup settings from 0.4 to 1 times the sensor plug (I_n). Other adjustable rating plugs shall be available for more precise settings to match the application. Long-time delay settings shall be in nine bands from 0.5–24 seconds at six times I_r .
- .6 [Short-time pickup shall allow for nine settings from 1.5 to 10 times I_r . Short-time delay shall be in nine bands from 0.1–0.4 $I_2 t$ ON and 0–0.4 $I_2 t$ OFF.
- .7 Instantaneous settings on the trip units with LSI protection shall be available in nine bands from 2 to 15 times I_n . The Instantaneous setting shall also have an OFF setting when short-time pick-up is provided.
- .8 All trip units shall have the capability for the adjustments to be set and read locally by rotating a switch. [Optional: trip units shall have the capability to electronically adjust the settings locally and remotely to fine increments below the switch settings. Fine increments for pickup adjustments are to be one ampere. Fine increments for delay adjustments are to be one second.
- .9 Trip unit shall provide local trip indication [and capability to indicate local and remote reason for trip, i.e., overload, short circuit or ground fault.
- .10 [Ground-fault protection shall be available for solidly grounded three-phase, three-wire or three-phase, four-wire systems. Trip unit shall be capable of the following types of ground-fault protection: residual, source ground return, and modified differential. Ground-fault sensing systems may be changed in the field.
- .11 [Ground-fault settings for circuit breaker sensor sizes 1200 A or below shall be in nine bands from 0.2 to 1.0 times I_n . The ground-fault settings for circuit breakers above 1200 A shall be nine bands from 500 to 1200 A.
- .12 [Neutral current transformers shall be available for four-wire systems.
- .13 Trip units shall be capable of communicating on four wire **MODBUS**® networks without software interfaces (black boxes).
- .14 Trip units shall be available to provide additional protection by offering adjustable inverse definite minimum time lag (IDMTL). IDMTL provides optimized coordination by the

- .15 adjustment of the slope of the long-time delay protection. Trip units shall be available to provide real time metering. Metering functions include current, voltage, power and frequency. Metering accuracy shall be 1.5% current, 0.5% voltage, and 2% power. These accuracies include CT and meter.
- .16 Trip units shall be available to provide harmonic analysis and waveform capture.
- .17 A means to seal the trip unit adjustments in accordance with NEC Section 240-6(b) shall be provided.
- .18 The following table indicates the standard and optional features of the Trip Units. Select the appropriate trip unit (s) for the system performance desired.

Features	Micrologic Trip Unit Series			
	Standard	A	P	H
True RMS Sensing	X	X	X	X
LI	X	X	X	X
LSI	o	o	X	X
LSIG/Ground –Fault Trip		o	o	o
Ground Fault Alarm (no trip)			X	X
Ground Fault Trip and Programming Alarm			o	o
Adjustable Rating Plugs	X	X	X	X
LED - Long-time Pickup	X	X	X	X
LED - Trip indication		X	X	X
Digital Ammeter		X	X	X
Phase loading Bar Graph		X	X	X
Zone Selective Interlocking		X	X	X
Communications		o	X	X
LCD Dot Matrix Display			X	X
Advanced User Interface			X	X
Protective Relay Functions			X	X
Thermal Imaging			X	X
Neutral Protection			X	X
Electronic Contact Wear Indication			X	X
Temperature Indication			X	X
Incremental Fine Tuning of Settings			X	X
Selectable Long-time Delay Bands			X	X
Power Measurement			X	X
Waveform Capture				X
Data Logging				X

X=Standard o=Option

- .2 Main Fusible Switch
- .1 Shall be QMQB type fusible switch 400 through 1,200A, BOLT-LOC fixed mounted bolted pressure switch 1,600 through 3,000A.
- .2 Bolted pressure contacts shall be made by providing an additional

- pressure or clamping action at both ends of the switchblade when the blades are fully closed.
- .3 Manual operated switches shall have quick-make, quick-break front operating mechanisms.
- .4 Accessories shall be supplied as follows:
 - Capacitor trip power supply]
 - Blown main fuse indication
 - Phase failure relay with capacitor trip power supply
 - Key interlock
- .5 Equipment ground fault protection
 - .1 Provide a zero-sequence type ground fault system including current sensor and appropriate relaying equipment. The current sensor shall enclose all phase (and neutral, if present) conductors to be monitored. The current sensor frame shall be so constructed that one leg can be opened to allow the removal of the sensor without disturbing the cables or requiring drop-links in the bussing. A test winding shall be provided to simulate the flow of ground fault current through the current sensor for testing.
 - .2 The ground fault relay shall be of solid state construction and have adjustable pick-up for ground fault currents from 100 amperes to 1200 amperes.

2.6 NOT USED.

2.7 Metering and Accessories

- .1 Main Metering
 - .1 Metering requirements that exceed the capabilities of the circuit breaker trip units shall use the Schneider Electric Powerlogic Circuit Monitor 4000T Powerlogic PM8244, Powerlogic PM5563, [Powerlogic ION7550 Powerlogic ION7650, Powerlogic ION8650
 - .2 CT's shall be appropriately sized for use on the main
 - .3 Separate HMI displays shall be mounted on Main breaker door
 - .4 Instrument compartment door
 - .5 Meter integrated communication available via Serial port or Ethernet port depending on meter type.

- .2 Communications
 - .1 Equipment can be selected with communications from among the following options
 - .1 Modbus RS48, without device Web pages
 - .2 Modbus RS48, with device Web pages
 - .3 Modbus RS485 to Ethernet Modbus TCP
 - .4 Direct Ethernet Modbus/TCP
 - .3 Energy Reduction Maintenance Setting Switch (ERMS)
 - .1 For each Main Tie or Feeder circuit breaker, provide a Maintenance OFF ON selector switch on the compartment door to switch the circuit breaker instantaneous tripping characteristics to an alternate setting temporarily during maintenance activity.
 - .2 Provide a lock feature for the ERMS switch so that it may be locked in either the OFF or ON maintenance mode position.
 - .3 Provide a blue LED indicating light to indicate trip unit is in the ERMS mode.
 - .4 Wire contacts on all ERMS switches to a common alarm input to plant control system.

2.8 GROUND FAULT PROTECTION

- .1 3-phase 4-wire, connected equipment having multiple sources shall have a modified differential ground fault system (MDGF). The manufacturer shall complete the MDGF design prior to building equipment to insure that the proper main or tie breaker (s) operate properly during the following occurrences on the main bus.
 - .1 Insure the system will trip with the occurrence of a ground fault at any location in the switchgear.
 - .2 Insure system will not trip without ground fault and with normal current flow.
 - .3 Insure system will not trip due to large single-phase currents.
 - .4 Insure system will trip with combination of normal current flow and ground fault current flowing together.
 - .5 Insure system will not trip with circulating currents through the neutral due to multiple grounds and sources external to the immediate low voltage power sources.
- .2 The manufacturer shall be required to include additional CT's, ground fault relays, interlocks, wiring, components etc. to insure the ground fault systems operates without nuisance tripping on the main bus of the switchgear.
- .3 The manufacturer shall include a wiring diagram of the MDGF system along with a test procedure using high current injection equipment.

2.9 DISTRIBUTION SECTION DEVICES

- .1 Group mounted circuit breakers through 100A to 1200A
 - .1 Breakers and all components shall be designed, manufactured and tested in accordance with applicable CSA standards.
 - .2 Circuit breaker(s) shall be rated for 80% continuous current.
 - .3 Circuit breakers(s) shall have 10kA, 14 kA, 18 kA, 25 kA 35 kA 42 kA 50 kA 65 kA interrupting capacity at 208Vac. Two tier CSA or UL listed series ratings are acceptable. When series ratings are applied with integral or

-
- remote upstream devices, a label or manual shall be provided showing the CSA or UL approved series ratings including:
- Voltage
 - Size and type of upstream fuses or breakers
 - Size and type of branch devices that can be used
- .4 Circuit breaker(s) shall be group mounted plug-on with mechanical restraint on a common pan or rail assembly.
- .5 The interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.
- .6 Circuit breakers equipped with line terminal jaws shall not require additional external mounting hardware. Circuit breakers shall be held in mounted position by a self-contained bracket secured to the mounting pan by fasteners. Circuit breakers of different frame sizes shall be capable of being mounted across from each other.
- .7 Line-side circuit breaker connections are to be jaw type.
- .8 All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.
(Select Electronic trip 100%, Electronic trip 80% or Thermal Magnetic)
- .1 Electronic trip molded case full function 100% rated circuit breakers
- .1 All electronic circuit breakers shall have the following time/current response adjustments: Long Time Pickup, Long Time Delay, Short Time Pickup, Short Time Delay, Ground Fault Pickup Ground Fault Delay and Instantaneous settings. Each adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.
 - .2 Circuit breaker trip system shall be a microprocessor-based true RMS sensing designed with sensing accuracy through the thirteenth (13th) harmonic. Sensor ampere ratings shall be as indicated on the associated schedule/ drawing.
 - .3 Local visual trip indication for overload, short circuit and ground fault trip occurrences.

- .4 Long Time Pickup indication to signal when loading approaches or exceeds the adjustable ampere rating of the circuit breaker shall be provided.
- .5 Communications capabilities for remote monitoring of circuit breaker trip system, to include phase and ground fault currents, pre-trip alarm indication, switch settings, and trip history information shall be provided.
- .6 Circuit breaker shall be provided with Zone Selective Interlocking (ZSI) communications capabilities on the short-time and ground fault functions compatible with all other electronic trip circuit breakers and external ground fault sensing systems as noted on schedules/drawings.
- .7 Furnish thermal magnetic molded case circuit breakers for 250A frames and below.
- .2 Electronic trip molded case standard function 80% rated circuit breakers
 - .1 All electronic circuit breakers shall have the following time/current response adjustments: Long Time Pickup, Long Time Delay, Short Time Pickup, Short Time Delay, Ground Fault Pickup Ground Fault Delay and Instantaneous settings. Each adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.
 - .2 Circuit breaker trip system shall be a microprocessor-based true RMS sensing designed with sensing accuracy through the thirteenth (13th) harmonic. Sensor ampere ratings shall be as indicated on the associated schedule/drawing.
 - .3 Local visual trip indication for overload, short circuit and ground fault trip occurrences.
 - .4 Long Time Pickup indication to signal when loading approaches or exceeds the adjustable ampere rating of the circuit breaker shall be provided.
 - .5 Furnish thermal magnetic molded case circuit breakers for 250A frames and below.
- .3 Thermal magnetic molded case circuit breakers
 - .1 Molded case circuit breakers shall have integral thermal and instantaneous magnetic trip in each pole.
 - .2 Circuit protective devices shall be Square D molded case circuit breakers. Circuit breakers shall have 10kA, 14kA, 18kA, 25kA, 35kA, 50kA, 65kA. True current limiting* interrupting capacity at 208Vac. Ampere ratings shall be as shown on the drawings.
* Manufacturer shall submit one set of published I_p and I^2t let-through curves (as required by CSA or UL) to the owner.

3. Execution

3.1 INSTALLATION

- .1 Install switchboards in accordance with manufacturer's written instructions, and applicable standards and safety codes.

3.2

FIELD QUALITY CONTROL

- .1 Inspect complete installation for physical damage, proper alignment, anchorage, and grounding.
- .2 Measure steady state load currents at each switchboard feeder; rearrange circuits in the switchboard to balance the phase loads within 20% of each other. Maintain proper phasing for multi-wire branch circuits.
- .3 Check tightness of bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written specifications.

END OF SECTION

1. General

1.1 DESCRIPTION

- .1 Provide molded case circuit breaker switches and panelboards type CDP for 120/208 volt distribution as indicated on the drawings. Approved manufacturer Schneider to maintain series rating with main distribution. Integrated equipment rated with upstream protective devices.

2. Products

2.1 MOULDED CASE CIRCUIT BREAKER

- .1 Rating: voltage and ampere ratings as shown, 3 pole unless shown otherwise.
- .2 Construction: Equipped with thermal time delay trip, magnetic instantaneous trip, overcentre toggle mechanism, silver alloy contacts, high contact pressure, common trip for 2 or 3 pole, air chute arc extinguishers, three position handle,
- .3 Frame Sizes: Schneider frame sizes shown on the drawings and indicate standard or hard case. In all cases, breakers shall be of a type completely protected by the upstream breakers used in the feeder to the panelboard.
- .4 Connectors: Solderless pressure lugs, sized for cables, bolt-on bus connections.
- .5 Special Features: Where indicated on the drawings, provide special features, such as shunt trips for remote operation, keyed interlocks, non-auto, solid

2.2 INDIVIDUAL MOUNTED MOULDED CASE CIRCUIT BREAKER

- .1 Breaker Switches:
 - .1 Enclosures: CSA Code gauge galvanized steel, hinged door, front mounted external operating handle, lockable in "OFF" position, EEMAC-1 unless shown otherwise. Exterior breakers and switches showed WP on drawings to have EEMAC-12 enclosures. Increase enclosure size above standard for large cables.
 - .2 Neutral Bars: Where distribution system has grounded neutral conductor, provide neutral bar, with ampere rating equal to switch rating, in enclosure.

2.3 CDP PANELBOARDS

- .1 Construction: To CSA Standards, apply CSA approval labels.
- .2 Voltage and ampere ratings as shown, 3 phase, 4 wire solid neutral for 4 wire distribution system.
- .3 Tubs: CSA code gauge galvanized steel, braced to support interiors, 102 mm x 32 mm support channels full width front and back on floor mounted.
- .4 Mains: Copper bus ampere rating as shown on the drawings, braced to minimum 42 KA unless shown otherwise on the drawings. Minimum bracing to I.C. of noted breakers.
- .5 Neutral Bus: Provide neutral bus with ampere rating equal to the panelboard mains for all distribution systems with grounded neutral conductor connections. Provide ground bars to panels as noted.

- .6 Breaker Arrangement: As shown on the drawings. Minor changes permitted to suit manufacturer.
- .7 Front Covers, Doors: CSA code gauge galvanized steel; fronts to cover wiring gutter space between breakers and tub sides, same size as tubs and flush with sides; with steel trim attached to back of covers to close space between covers and breakers; doors with concealed hinges, combination locks and latches, to
- .8 Finish: One primer coat and one finish coat on all metal surfaces and doors.
- .9 Panelboards in Switchboards: Modify enclosure construction to suit switchboard.
- .10 Breaker Spaces: Provide spaces for future breakers with ampere ratings and frame sizes as shown. Allow at least 40% space.
- .11 Special Features: Provide drip hoods, non-ferrous entry plates and other special features as shown on the drawings.
- .12 Main Breakers: Three pole, molded case circuit breakers, ampere sizes and frame sizes as shown.
- .13 CU/AL rated.

3. Execution

3.1 INDIVIDUAL MOUNTED MOULDED CASE CIRCUIT BREAKER

- .1 Mounting: Provide supports independent of conduits. Wall mount where possible, otherwise provide steel angle frame supports. Where switches are grouped, mount in uniform arrangement.
- .2 Wiring: Connect line and load cables to all switches.
- .3 Identification: Provide lamacoid plate on each switch showing voltage, phases and wires, source of supply and load being fed -

Voltage, phases and wire e.g. 120/208, 3 phase, 4
wire Fed from MDP No. 1
To Panel A

3.2 CDP PANELBOARDS

- .1 Mounting: Provide supports independent of conduits, mount as shown on the drawings. Bolt floor mounted panelboards to floor.
- .2 Wiring: Connect supply and all branch circuit breakers. Install branch breaker cables in neat bundles at sides of cable gutters. Install cables to branch circuit breakers horizontally.
- .3 Identification: Provide lamicoid plate on each panelboard cover showing panelboard designation, voltage and source of feed -

Panelboard "A"
Voltage, phases and wires e.g. 120/208V, 3 phase, 4
wire Fed from CDP "B"

- .4 Identify each branch circuit breaker with a lamicoid plate to show load
being fed - To Panel "PPA"

END OF SECTION

1. General

1.1 DESCRIPTION

- .1 Provide panelboards for 120/208 volt branch circuit distribution as indicated on schedules shown on the drawings, complete with all items listed.
- .2 Construct panelboards to CSA Standards, apply CSA approval labels.
- .3 Panelboards to be manufactured by Schneider.
- .4 Supply shop drawings on all panelboards, switchboards and CDP's.

2. Products

2.1 MATERIALS

- .1 Tub: CSA code gauge galvanized steel, reversible top and bottom, finish painted ANSI 61 grey enamel or as specified in Section 26 05 01.
- .2 Mains: Copper, ampere ratings as shown, solderless lug connectors sized for cables in panels without main breakers, bolt-on connectors for all main breakers and branch circuit breakers.
- .3 Neutral Bars: Same ampere ratings as mains, solderless lugs for connections.
- .4 Front shields to cover breaker assembly and neutral bars, leaving wiring gutters accessible when fronts removed.
- .5 Front Covers, Doors: CSA code gauge galvanized steel, with doors, concealed hinges, combination locks and latches, interior plastic covered circuit directory cardholders, concealed mounting screws, finish painted, same size as tubs where surface mounted, overlapping trim with wall gaskets where flush
- .6 Locks, Keys: All locks keyed alike.
- .7 Branch Circuit Breakers: Thermal magnetic with "ON", "OFF" and "TRIPPED" positions, single, two and three pole as shown; ampere ratings as shown; bolt-on line connections, solderless lug load connections; common trip for two and three pole; rated 240 volt 10,000 amps symmetrical short circuit interrupting capacity in 120/208 volt (Unless noted otherwise on single line drawing.) Breakers to be integrated equipment rated with upstream protective devices.
- .8 Spaces: Stamp out spaces, install removable fillers where breaker spaces are required.
- .9 Ground Fault Circuit Interrupters: Breakers having both 5 ma ground fault sensitivity and over current protection, of the amperage rating indicated, shall be installed in the panelboards where required. Wire each ground fault breaker with a separate neutral conductor wired through the interrupter to the ground
- .10 CU/AL Rated.

3. Execution

3.1 MOUNTING

- .1 Provide supports independent of conduits. Match trim and door heights on adjacent panelboards. Coordinate mounting heights with fire hose cabinets and other equipment as instructed by the A/E.

3.2 WIRING

- .1 Install branch circuit wiring in neat bundles at sides of wiring gutters, with wires to branch breakers horizontal.

3.3 IDENTIFICATION

- .1 Provide lamicoid plate securely and permanently attached to the exterior of each panelboard door showing panelboard designation, voltage and
- .2 For all ground fault breakers, provide a sign indicating that circuits are so protected and that equipment should be tested regularly.

3.4 BRANCH CIRCUIT DIRECTORY

- .1 Provide typed directory identifying all branch circuits. Directory to indicate device and location.

3.5 LOCKING STRAPS

- .1 Locking Straps: To permit automatic tripping of breakers but prevent manual switching, for exit lights, receptacles feeding emergency battery packs, data racks, security panels, UPS receptacles, and where designated.

3.6 KEYS

- .1 Provide 3 keys to Owner per panel.

3.7 CONDUIT STUBS

- .1 From each panelboard installed flush, provide 3 - 12 mm and 2 - 25 mm spare conduits from the panelboard tub to an accessible location in the ceiling space

END OF SECTION

1. General

1.1 RELATED WORK

- .1 Installation of anchor devices, Section 26 05 29 – Hangers, Supports and Inserts, channel base Cast-in-Place sills, setting Concrete templates.

1.2 REFERENCES

- .1 CAN/CSA-Q9000-92, Quality Management and Quality Assurance Standards - Guidelines for Selection and Use.

1.3 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 26 05 01 – Electrical General Requirements.
- .2 Indicate:
 - .1 Outline dimensions
 - .2 Configuration of identified compartments.
 - .3 Floor anchoring method and dimensioned foundation template.
 - .4 Cable entry and exit locations.
 - .5 Dimensioned position and size of busbars and details of provision for future extension.
 - .6 Schematic and wiring diagrams.

1.4 OPERATION AND MAINTENANCE DATA

- .1 Provide operation and maintenance data for motor control centre for incorporation into manual specified in Section 26 05 01 – Electrical General Requirements.
- .2 Include data for each type and style of starter.

1.5 SOURCE QUALITY CONTROL

- .1 Provide manufacturer's type test certificates including short circuit fault damage certification up to short circuit values specified under bus bracing.
- .2 Owner to witness standard factory testing of complete motor control centre including operation of switches, circuit breakers, starters and controls.
- .3 Manufacturer to provide proof of quality control program in accordance with CAN/CSA- Q9000.

2. Products

2.1 SUPPLY CHARACTERISTICS

- .1 600 V as indicated on the drawings, 60 Hz, Y connected, 3 phase, 3 wire, grounded.

2.2 GENERAL DESCRIPTION

- .1 Compartmentalized vertical sections with common power busbars.
- .2 Floor mounting, free standing, enclosed dead front.

- .3 Indoor CSA 2 enclosure, front mounting.
- .4 Class I Type A.

2.3 VERTICAL SECTION CONSTRUCTION

- .1 Independent vertical sections fabricated from rolled flat steel sheets bolted together to form rigid, completely enclosed assembly.
- .2 Each vertical section divided into compartment units, minimum 305 mm high, as indicated.
- .3 Each unit to have complete top and bottom steel plate for isolation between units.
- .4 Horizontal wireways, equipped with cable supports, across top and bottom, extending full width of motor control centre, isolated from busbars by steel
- .5 Vertical wireways c/w doors for load and control conductors extending full height of vertical sections and equipped with cable tie supports. Installation wiring to units accessible with doors open and units in place
- .6 Openings, with removable coverplates, in side of vertical sections for horizontal wiring between sections.
- .7 Incoming cables to enter at top with terminals as indicated.
- .8 Provision for outgoing cables to exit via top or bottom with terminals.
- .9 Removable lifting means.
- .10 Provision for future extension of both ends of motor control centre including busbars without need for further drilling, cutting or preparation in field.
- .11 Divide assembly for shipment to site, as indicated complete with hardware and instructions for re-assembly.

2.4 SILLS

- .1 Continuous 76 mm channel iron floor sills for mounting bases with 19 mm diameter holes for bolts.

2.5 BUSBARS

- .1 Main horizontal and branch vertical, three phase high conductivity solid copper busbars in separate compartment bare self-cooled, extending entire width and height of motor control centre, supported on insulators and rated:
 - .1 Main horizontal busbars: 600 A.
 - .2 Branch vertical busbars: 300 A.
- .2 Branch vertical busbars for distribution of power to units in vertical sections.
- .3 No other cables, wires, equipment in main and branch busbar compartments.
- .4 Brace buswork to withstand effects of short-circuit current of 42 kA rms symmetrical or as indicated by the fault study.

- .5 Bus supports: with high dielectric strength, low moisture absorption, high impact material and long creepage surface designed to discourage collection of dust.

2.6 GROUND BUS

- .1 Copper ground bus extending entire width of motor control centre.
- .2 Vertical ground bus strap, full height of section, tied to horizontal ground bus, engaged by plug-in unit ground stab.

2.7 STARTER UNIT COMPARTMENTS

- .1 Units EEMAC size 5 and smaller, circuit breaker units 225 A and smaller, plug-in type with self-disconnect. Guide rail supports for units to ensure that stabs make positive contact with vertical bus. Provision for units to be installed or removed, off load, while buses energized.
- .2 Unit mounting:
 - .1 Engaged position - unit stabbed into vertical bus.
 - .2 Withdrawn position - unit isolated from vertical bus but supported by structure. Terminal block accessible for electrical testing of starter.
 - .3 Provision for positive latching in either engaged or withdrawn position and padlocking in withdrawn position.
 - .4 Stab-on connectors free floating tin plated clips, self-aligning, backed up with steel springs.
- .3 External operating handle of circuit switch interlocked with door to prevent door opening with switch in "on" position. Provision for 3 padlocks to lock operating handle in "off" position and lock door closed.
- .4 Hinge unit doors on same side.
- .5 Overload relays manually reset from front with door closed.
- .6 Pushbuttons and indicating lights mounted on door front.
- .7 Devices and components by one manufacturer to facilitate maintenance.
- .8 Pull-apart terminal blocks for power and control to allow removal of starter units without removal of field wiring.
- .9 Provide single phase protection for all three phase motors either by relaying, differential overloads, or EMCS shutdown.

2.8 WIRING IDENTIFICATION

- .1 Provide wiring identification in accordance with Section 26 05 53 - Electrical General Requirements.

2.9 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 01 - Electrical General Requirements.

- .1 Motor control centre main nameplate: engraved 1.
- .2 Individual compartment nameplates: engraved as indicated.

2.10 FINISHES

- .1 Apply finishes in accordance with Section 26 05 53 - Identification.
- .2 Paint motor control centre exterior light gray and interiors white.

2.11 ACCEPTABLE MANUFACTURERS

- .1 Schneider

3. Execution

3.1 INSTALLATION

- .1 Set and secure motor control centre in place on channel bases, rigid, plumb and square to building floor and wall.
- .2 Make field power and control connections as indicated.
- .3 Ensure correct overload heater elements are installed.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 01 26 – Testing, Adjusting and Balancing of Electrical Equipment and Systems.
- .2 Ensure moving and working parts are lubricated where required.
- .3 Operate starters in sequence to prove satisfactory performance of motor control centre during 8 h period.

END OF SECTION

1. General

1.1 RELATEDWORK

- | | | |
|----|---|------------------|
| .1 | Connections to Mechanical Equipment | Section 25 30 01 |
| .2 | Connections to Wiring Systems Installed | Section 26 27 11 |
| .3 | Motor Identification | Section 25 05 55 |

1.2 STARTER REQUIREMENTS

- .1 In general, there are three categories of starting equipment for three phase motors.
 - .1 Integral Mounted Starters: Some items of mechanical equipment such as boilers, have the starter mounted as part of the equipment. For this equipment, supply disconnects and wire to the terminals of the equipment.
 - .2 Separately Mounted Starters: For motors without integral mounted starters, supply separately mounted starters as indicated on the Drawings and wire the equipment.
- .2 Provide manual motor starters for all single phase motors unless otherwise indicated on the motor schedule.
- .3 Provide interlocking between starters where required.
- .4 All starter accessories such as pilot lights, Hand-Off-Auto, Start-Stop, etc., whether integrally or remote mounted shall be heavy-duty oil tight, unless otherwise specified.
- .5 Review and coordinate all starter characteristics with specific motors. Ensure all two speed motor starters are compatible with motors supplied by Division 25.

1.3 CONTROLS

- .1 The work of this Division shall not include the wiring of HVAC controls, such as freeze stats, fire stats, E.P. and P.E. switches.

1.4 SHOPDRAWINGS

- .1 Obtain wiring diagrams and information from other trades on control systems. Coordinate and incorporate information on motor control centre shop drawings.
- .2 Prepare shop drawings and wiring diagrams for motor control centre under supervision of suitably qualified staff.
- .3 Consult with the A/E during preparation of shop drawings as required to ensure correct interpretation.

2. Products

2.1 MOTOR STARTERS GENERAL

- .1 Except where specifically noted otherwise, this Division shall supply and install all motor starters. Starters to be combination type with current limiters when indicated in new grouped 4 plex Motor Control.
- .2 Starters to IEC 292 or EEMAC standards. Interrupting capacity minimum 10 kA.

- .3 All individually mounted motor starters shall be enclosed in a general-purpose sheet steel enclosure unless in wet areas where they shall be watertight EEMAC 4.

2.2 MANUAL MOTOR STARTERS:

- .1 Where manual motor starters are indicated, provide manual motor starter switches with "ON" pilot lights, and overload protective devices, manual reset, trip indicating handle.
- .2 Starters to have quick make quick break toggle switch operation, rated volts, and poles, to suit application. Locking tab to permit locking in the "ON" of "OFF".

2.3 FULL VOLTAGE MAGNETIC STARTERS:

- .1 All three phase magnetic motor starters to be across-the-line magnetic starters, except as noted. Each FVNR starter shall contain within its enclosures:
 - .1 Contactor with three overload devices having either one form A and one form B contact, or an auxiliary relay. Overload trip contacts shall be wired to the line side of the contactor coil such that the neutral side of the coil is wired directly to the grounded circuit.
 - .2 A control transformer of sufficient VA capacity to provide 120 volt control complete with primary and secondary fuses for all ungrounded conductors installed with starter. Fuses to be English Electric "red spot" fuse fitting CCRS154. Size for load plus 20% sparer capacity.
 - .3 Two sets of auxiliary contacts (2NO and 2 NC) in addition to standard with provision to convert one set to normally closed.
 - .4 Red pilot light to indicate energized motor circuit and where called for green pilot light to indicate de-energized motor circuit. Pilot lights shall LED be push-to-test transformer type, heavy duty, oil tight.
 - .5 Thermistor control relay and accessories for all motors 22.4 kW and above.
 - .6 Starters for motors 5hp and larger shall have single phase protection.
- .2 All combination motor starters shall be of the circuit breaker type complete with HRC Form J fuses, unless otherwise indicated. Combination starters shall have external operating handle with lock off facilities, lock on position. Entry door shall be fitted with switch/door interlock devices.
- .3 Accessories as indicated except standard duty HOA, 2 N/O and 2 NC spare auxiliary contacts.
- .4 Supply and install overload heaters and one overload device on each phase.
- .5 Provide lamicoid nameplates with lettering as indicated. The equipment name and number shall be indicated. See "Identification" Section 26 05 01.
- .6 Switches shall not be accessible to unauthorized personnel, e.g. mount in service rooms.

3. Execution

3.1 STARTER VERIFICATION

- .1 Field check motor starters supplied prior to commissioning equipment. As a minimum, verify the following:
 - .1 Check of control circuits
 - .2 Verify that overload relay installed is correctly sized for motor sued.
 - .3 Record overload relay size and motor nameplate amperage.

- .4 Visual inspection of fuses and contactors.
- .5 Ensure all connections are tight.
- .2 Measure and record motor amps, under load conditions and compare with full load amps and motor service factor. Report any excessive readings and unbalance. Measure voltage as close to motor terminals as possible while motor is running.
- .3 Set all motor circuit protectors to the minimum level which will consistently allow the motor to start under normal starting conditions.
- .4 Refer to Section 26 05 82 "Motor Identification".

3.2 OVERLOAD RELAYS

- .1 For starters provided, select overload relays in accordance with relay and motor manufacturers' recommendations, considering motor service factors, ambient temperature, temperature differences between motor and starter locations. Monitor motor operation during startup to ensure motor operation is satisfactory and relays provide proper protection. For side inlet fans and other long acceleration time motors, provide special overload relays to suite the start-up condition. Provide manufacturers' curves and data sheets where necessary to provide supporting data for motor protection.
- .2 Overload heaters when equipped with an adjustable dial setting to be set up to suit site conditions and motor characteristics.

END OF SECTION

1. General

1.1. SCOPE

- .1 The work under this section includes electronic meters including test switch and instrument transformers as specified herein and shown on the Drawings. Included are the following topics:

1.2. RELATED WORK

- .1 Applicable provisions of Division 1 govern work under this Section
- .2 Section 01 91 01 or 01 91 02 – Commissioning Process
- .3 Section 26 08 00 – Commissioning of Electrical
- .4 Section 26 24 13 – Switchboards
- .5 Section 26 24 16 – Panelboards

1.3. REFERENCES

- .1 ANSI C57.13 – Instrument Transformers

1.4. SUBMITTALS

- .1 Provide product data showing model numbers, dimensions, mounting requirements, and parameters measured and displayed.

1.5. OPERATION AND MAINTENANCE DATA

- .1 All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

2. Products

2.1. UTILITY METERING

- .1 Provide a stand-alone CT cabinet, or a separate utility metering section in the switchboard. Provide a meter socket with a 1-inch conduit to the CT cabinet. Coordinate approved manufacturer(s), style, and location of metering equipment with local utility requirements.

2.2. ELECTRONIC METER at MAIN ELECTRIC SERVICE (Non-Utility Metering)

- .1 Electronic meter with digital display (LED or LCD), shall accept input from standard current transformers rated 5 amperes. Meters for systems operating at 480V and below shall measure circuit potential without the use of external potential transformers. Meter shall be suitable for connection to a three-phase, four-wire wye system or a three-phase, three-wire delta system.
- .2 Meter accuracy shall be 0.5% of actual reading (not full-scale measurement).
- .3 Meter shall display actual numeric values without requiring the use of a multiplier. Meter shall measure and display the following:
 - .1 Current: per phase
 - .2 Voltage: phase-to-phase and phase-to-neutral
 - .3 Real Power (kW): three-phase total
 - .4 Reactive Power (kVAR): three-phase total
 - .5 Apparent Power (kVA): three-phase total
 - .6 Power Factor: three-phase
 - .7 Real Energy (kWh): three-phase total
 - .8 Maximum Demand

- .1 Real Power (kW): three-phase total
- .2 Apparent Power (kVA): three-phase total
- .4 All meter potential leads and control power leads shall be fuse protected. Provide a fused disconnecting device or circuit breaker with downstream fuses in the main switchboard or panelboard for protection of the meter potential leads and control power leads. Fuses shall be sized per manufacturer's recommendations.
- .5 Provide a Meter Interface Gateway device to convert the meter's Modbus RTU output (measured values listed above) to BACnet/IP for interface Building Automation System (BAS). Meter gateway device shall include a prebuilt template for the PQMII of the information. Gateway to be provided is: Real Time Automation – model RTA-460MX-S051. Consult with personnel for proper wiring and termination procedures and gateway software configuration.
- .6 The electrical contractor shall be responsible for providing all communication wiring between the meter and the interface gateway and shall provide Ethernet communication wiring from the interface gateway to the IT closet.
- .7 Building Automation System (BAS) data jacks will be installed according to the building standard except that a data jack is not needed, and a patch cord can be used between the utilizing equipment and the network switch port under the following exceptions:
 - .1 If the utilizing equipment is mounted on or within the vertical sides of the floor or wall rack.
 - .2 If the utilizing equipment is mounted within the same telecommunications room and can be reached with a 40 foot or shorter patch cord that is routed with existing cabling in the racks, trays, J-hooks, etc...and is not stretched tight.

NOTE: If a patch cord is used in exceptions A or B above, the patch cord must be labeled on each end listing the termination point on the opposite end.

EXAMPLE:

Switch name and port #.....to..... equipment name
s-weeks-156-1-access, port 22.....MS-SECVT0 north wall

[Provide a Meter Interface Gateway as described in the "Meter Interface Gateway" subsection of this specification.]

2.3. METER TEST SWITCH

- .1 Provide a 600 volt ten-pole (4 potential and 6 current shorting) test switch with cover, ABB Type FT-1, or approved equal, connected between each meter and the CT and potential leads. The six leads (2 per phase) from the CT's shall be connected to the current shorting terminal positions on the test switch. The four leads ((3) phase and (1) neutral) from the PT's or bus shall be connected to the potential terminal positions. The test switch shall be located on the face of the switchgear adjacent to the meter or behind a panel cover in an easily accessible location.
- .2 Meter test switch is required on all meter installations at switchboards and main distribution panels. Meter test switch is not required for sub-meters, or meters installed at branch panels, automatic transfer switches, and other downstream locations.

2.4. SUB-METER(S)

- .1 Electronic meter with digital display shall accept input from standard current transformers rated 5 amperes. Sub-meters may use 0-2V Current Sensors or 0-0.333V Current Transducers in lieu of Current Transformers. Meter shall be suitable for connection to a three-phase, four-wire wye system, a three-phase, three-wire delta system, or a 120/240V single-phase system. Meter specification is based on Electro Industries Shark 100 or equal.
- .2 Meter accuracy shall be 1.0% of actual reading (not full scale measurement).
- .3 Meter shall display actual numeric values without requiring the use of a multiplier. Meter shall measure and display the following:

- .1 Current: per phase
- .2 Voltage: phase-to-phase and phase-to-neutral
- .3 Real Power (kW): three-phase total
- .4 Reactive Power (kVAR): three-phase total
- .5 Apparent Power (kVA): three-phase total
- .6 Power Factor: three-phase
- .7 Real Energy (kWh): three-phase total
- .8 Maximum Demand:
 - .1 Real Power (kW): three-phase total
 - .2 Apparent Power (kVA): three-phase total

[Meters for dormitory suites [shall be provided with LCD displays.] [shall not be provided with displays.]]

[Provide Meter Interface Gateway per the paragraph included in this specification section.]

- .4 Provide additional fusible disconnect switch(es)/circuit breaker(s) and enclosures per the PROVISIONS FOR SUB-METERS paragraph included in this specification section.
- .5 MULTI-POINT SUB-METERING SYSTEM: Where multiple sub-meters are desired in a common location, the following multi-point sub-metering system may be used:
 - .1 The Unit shall consist of either of two circuit configurations: 8 multifunction electrical measuring points (meters) for 3 phase power systems or 24 multifunction electrical measuring points (meters) for single phase power systems. The Unit's meters shall perform to spec in harsh electrical applications in high and low voltage power systems.
 - .2 Meter accuracy shall be 1.0% of actual reading (not full scale measurement).
 - .3 The Unit shall have optional data-logging memory of up to 32MB. With data-logging, the Unit shall support:
 - .1 Two pre-configured Historical logs: Log 1 for trending Voltage and Frequency, Log 2 for trending Energy use over time.
 - .2 An Alarm/Limits log that records the state of the 16 limits that can be programmed for the meter
 - .3 A System Events log to store events that happen in, or to the meter, including Startup, Reset commands, Log retrievals, and attempts to log on with a password.An I/O Change log to record changes in the inputs and outputs of the Relay Output/Status Input board.
 - .4 The Unit's meters shall be traceable revenue meters. The Unit which shall contain utility grade test pulses allowing power providers to verify and confirm that the meters are performing to their rated accuracy
 - .5 The Unit shall offer the following communication ports
 - 1. Com 1 shall support RS485 and optional RJ45 Ethernet/802.11b Wi-Fi. It shall support Modbus RTU, Modbus ASCII, and Modbus TCP; and baud rates from 9,600 to 57,600.
 - 2. Com 2 shall be a USB Serial port. It shall support Modbus ASCII and a baud rate of 57,600.
 - 3. Com 3 shall support RS485. It shall support Modbus RTU and Modbus ASCII; and baud rates from 9,600 to 57,600.
 - .6 The Unit shall have a Relay Output/Status Input board.
 - 1. The board shall have 2 Relay Outputs for control applications. The relay outputs shall be able to be triggered by the user-programmed limits in the meters. The user shall be able to assign up to 16 limits, including below-and above-limit conditions for any value the meter measures.

2. The board shall have 4 KYZ Counting Inputs. The KYZ inputs shall be able to be configured to count pulses from gas, water, condensate, and other commodity measuring devices.
- .7 The Unit shall consist of an all-metal enclosure and shall have the following physical properties:
 1. The Unit shall be able to be mounted within an electrical panel.
 2. The Unit shall have a stud-base connection for current inputs

2.5. METER INTERFACE GATEWAY

- .1 Provide a meter interface gateway to allow the meter(s) (daisy-chained to a single interface location) to communicate with the BAS system protocol listed below. The interface gateway shall convert the meter data from the meter's native language to the BAS protocol.
- .2 If the meters can communicate with the BAS system without the use of an interface gateway, then no gateway is required.
- .3 Existing Building Automation System (BAS) communication protocol:
 - .1 BACnet/IP. Meters that have internal BACnet/IP communication interface: Electro Industries Shark 100B series or equal.

[The Main Electric Service meter] [and all Sub-meters] shall have a BACnet/IP interface (either on-board or a separate gateway) to the BAS system.

The Division 26 electrical contractor shall be responsible for providing all communication wiring between the meters, between the meters and the interface gateway, and between the gateway and the telecom switch. Coordinate with the facility IT staff.

- .2 BACnet/MSTP. Meters that have internal BACnet/MSTP communication interface: Veris H8163 series, Delta Controls DSM-PWR, or equal. For delta three phase feeders without a neutral leg, the Veris H8163 cannot be used.

[The Main Electric Service meter] [and all Sub-meters] shall have a BACnet/MSTP interface (either on-board or a separate gateway) to the BAS system.

The Division 23 Controls contractor shall be responsible for providing all communication wiring between the meters, between the meters and the interface gateway, and between the gateway and the BAS system. Coordinate with HVAC controls.

- .4 Manufacturers of gateway devices that can provide a BACnet interface for electrical meters with other native protocols: Industrial Control Communications, Inc. - Millennium Gateway Series, Real Time Automation – 460 Series, Delta Controls DSM-PWR, FieldServer, Tridium, or Johnson Controls. All programming of the gateway device to provide the BACnet objects to the building automation system shall be included
- .5 The interface gateway shall transmit all of the measured values listed under the meter descriptions in this specification section.

2.6. PROVISIONS FOR SUB-METERS

- .1 OVERCURRENT PROTECTION FOR POTENTIAL LEADS AND CONTROL POWER LEADS: If the sub-meter(s) are located in the main switchboard, provide a fusible disconnect or circuit breaker in the metering section of the switchboard for the protection of the potential transformers or potential leads as required for the sub-meter(s). If the sub-meter(s) are located adjacent to a panelboard, then the contractor must provide a 3-pole

15 amp circuit breaker in that panelboard as required for the potential transformers or potential leads for the sub-meter(s).

- .2 All meter potential leads and control power leads shall be fuse protected. Provide fuses in the disconnecting device or downstream fuses from the circuit breaker for protection of the meter potential leads and control power leads. Fuses shall be sized per manufacturer's recommendations.

- .3 **ENCLOSURE(S)**

- .1 If the sub-meters are located adjacent to the switchboard or panelboard, then:
The meters shall be provided in a common meter enclosure.

The meters shall be capable of being mounted in a common enclosure when there is more than one (1) meter.

The metering enclosure shall be provided with separate wiring troughs for line voltage and low voltage wiring.

The enclosure shall come equipped with a control power transformer.

The enclosure shall come with voltage fuses and a shorting block for use with current transformers.

The enclosure shall have a lockable door.

2.7. ACCESSORIES

- .1 Provide shorting block(s) for the CT leads.

2.8. CURRENT TRANSFORMERS

- .1 Current Transformers: ANSI C57.13; 5 ampere secondary, with primary/secondary ratio as shown on Drawings, burden and accuracy consistent with connected metering and relay devices, 60 Hz.
- .2 Sub-meters may use 0-2V Current Sensors or 0-0.333V Current Transducers In lieu of Current Transformers.
- .3 Mount and brace transformers to withstand 100,000 amp short circuit current.

2.9. POTENTIAL TRANSFORMERS

- .1 Provide potential transformers (PT's) only if required by the meter manufacturer. Most meters can measure 480V potential and below without the use of external PT's.
- .2 Potential Transformers: ANSI C57.13; 120 volt secondary, burden and accuracy consistent with connected metering and relay devices, 60 Hz.
- .3 Potential transformers on 480/277 volt systems shall be rated 277 – 120 volts, connected phase-to-neutral, and installed on each phase.

3. Execution

3.1. INSTALLATION

- .1 The meters shall be mounted in the locations indicated on the drawings. Mounting height shall be 5'-6" or less from finished floor.
- .2 New meters installed in existing equipment:
 - .1 All unused openings shall be covered with a metal closure plate painted to match the existing enclosure.
 - .2 Any extension of wiring needed to accommodate the meters shall be done using terminal blocks and #10 AWG stranded copper wire, 600 volt type SIS insulation.

Splices are not allowed

- .3 Provide a separate enclosure for the new meter if adequate space is not available in the existing panels.
- .4 Dangerous voltage will develop in the open circuit secondary windings of energized current transformers. De-energize the current transformers by short circuiting the secondary windings before disconnecting or connecting instruments to current transformers
- .5 Verify the proper operation of all meters. Compare the meter display readings to measurements taken with a clamp on amp-meter and hand held volt meter.
- .6 Provide all programming and field set-up of the meters required for measurement and communication of the electrical data.

3.2. CONSTRUCTION VERIFICATION

- .1 Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 26 08 00 in accordance with the procedures defined for construction verification in Section 01 91 01 or 01 91 02.

3.3. AGENCY TRAINING

- .1 All training provided for agency shall comply with the format, general content requirements and submission guidelines specified under Section 01 91 01 or 01 91 02.

END OF SECTION

1. General

1.1 SYSTEM

- .1 Conduit and outlets to form empty raceway system as indicated on the drawings.

2. Products

2.1 COMPONENTS

- .1 Conduit: Refer to Section 26 05 33.
- .2 Wall Outlet Boxes: Receptacle, blank coverplates and outlets as shown.
- .3 Wire Mold: Legrand G4000 series where shown.

3. Execution

3.1 GENERAL

- .1 Supply and install pullwire in all empty conduits.
- .2 Minimum conduit size 21mm.
- .3 Provide bushings on all conduits stubbed onto ceiling space.
- .4 Mount bottom of data outlets at 304 mm above finished floor or as noted drawings.
- .5 Junction boxes for outlets to be flush mounted in wall. Appropriate extension rings are to be provided where outlets are to be installed in millwork, backboards, chalkboards, etc.

END OF SECTION

1. General

1.1 WORK INCLUDED

- .1 Provide and connect all wiring devices for the complete installation.

2. Products

2.1 MANUFACTURER

- .1 Wiring devices to be of one manufacture throughout project unless noted.
- .2 Manufacturers shall be Acuity, Leviton, and Hubbell or approved equals.
- .3 Manufacturers shall be Leviton Decora style white for all key switches or approved equals. Provide a minimum of thirty (30) keys. Toggle switches not allowed.

2.2 DEVICES

- .1 The catalogue numbers shown below are for the particular manufacturer's series and all necessary suffixes shall be added for the requirements as stated. All devices shall be specification grade minimum and wherever possible shall be of the same manufacture.
- .2 Devices to be white with High Impact Smooth Nylon coverplates in all but mechanical areas unless noted otherwise. Use galvanized steel coverplates in mechanical areas and for surface mounted devices.

2.3 SWITCHES

- .1 Switches to be Leviton Decora white
- .2 120 volt, 15 amp, single and double pole, three and four-way: Leviton Decora series white
- .3 For wet locations use the following switches: 20A, 120V single pole white, side wired press-switch, as Leviton Decora series
- Leviton Universal dimmer DSL06-450W Led white
- Leviton Decora rocker slide control white
- Leviton ATE04-1L, ATE06-1L, ATE06-1L, IPE04-1L2, VPE04-1L, VPE04-1L, VPE06-1L
- .4 Do not gang Dimmer switches. Derate per manufacturer recommendation if ganged.

2.4 RECEPTACLES

- .1 Receptacles to be CSA C22.2 No. 42-M1984, duplex, 15A, 125 volt, U-ground.
- .2 Duplex 15 ampere, 120 volt, 3 wire, white, U-ground, as Leviton series.
- .3 Duplex 15 ampere, 120 volt, 3 wire, white, U-ground ground fault receptacle, Leviton series
- .4 Single 15 ampere 250 volt, 3 wire receptacle white with High Impact Smooth Nylon, as Leviton series.
- .5 Duplex 20 ampere, 125 volt, 3 wire, white, U-ground as Leviton NEMA 5-20R for standard outlet or equal.

- .6 Use single 5.20RA (T-slot) 20A duplex receptacle where indicated Leviton series white..

2.5 COVERPLATES

- .1 Provide coverplates for all wiring devices, including but not limited to telephone, computer, television.
- .2 Use sheet steel utility box cover for wiring devices installed in surface mounted utility boxes.
- .3 Use High Impact Smooth Nylon coverplates on all wiring devices mounted in flush-mounted outlet boxes unless otherwise specified including receptacles and light switches.
- .4 Weatherproof coverplates shall be as Leviton series for flush mounting and/or surface mounted. Must be Weatherproof in use to comply with CEC.
- .5 Use gasketed DS covers on FS and FD type boxes.

2.6 SPECIAL WIRING DEVICES

- .1 Class "A" ground fault circuit interrupter receptacles, similar to above, complete with zero sequence transformer , trip on 5 mA leakage current with provision for test and reset. 15A and 20A T-Slot.
- .2 Duplex 15 ampere, surge suppression receptacle as Hubbell No. 5262S. These outlets are required in all data communications rooms and rooms with more than ten computers (if the circuit is not from a SPD protected panel).
- .3 Twist Lock receptacles: where indicated and for theatrical lighting power bars.

3. Execution

3.1 INSTALLATION

- .1 Duplex receptacles used with data to be mounted at 787 mm to centre.
- .2 Install wall switches 48 inches (1200 mm) inches above floor, OFF position down.
- .3 Install switches vertically in gang type outlet box when more than one switch is required in one location.
- .4 Mount switches on the latch side of the doorway as close as possible to door frame unless otherwise indicated on drawings.

-
- .1 Install receptacles vertically in gang type outlet box when more than one receptacle is required in one location.
 - .2 Protect cover plate finish with paper or plastic film until all painting and other work is finished, then remove paper.
 - .3 Install suitable common coverplates where wiring devices are grouped. Do not distort plates by tightening screws excessively.
 - .4 Do not use coverplates meant for flush outlet boxes on surface mounted boxes.
 - .5 Wherever possible, mount equipment in a straight line at a uniform mounting height, coordinated with other equipment and materials.
 - .6 Mounting dimensions are to the centre of the devices. Final instructions on mounting heights shall be given by the A/E's representative at the site. The above shall be used as a guide, but shall be subject to final verification prior to installation.
 - .7 Supply and install a separate neutral conductor from branch circuit panel to devices for all dimmer control circuits.
 - .8 All wiring devices to be white in color.
 - .9 Drill opening for poke through fitting installation in accordance with manufacturer's instructions.
 - .10 Provide weatherproof, gasketed cover plates on flush mounted devices where shown, type and configuration to suit flush device and its orientation.
 - .11 Install blank and device cover plates on switches, receptacles and boxes.
 - .12 Provide GFCI protected 20Ampere receptacles in accordance with NEC - "Ground Fault Protection for Personnel" in bathrooms, garages, and receptacles mounted outside, and within 6 feet (1.8 m) of sinks in kitchen areas.
 - .13 All GFCI receptacles in wet areas shall be in weatherproof enclosure.
 - .14 In addition, GFI protection shall be provided for:
 1. Electrical receptacles within 6 feet (1.8 m) of the sinks or developing tanks in Dark rooms, and within 6 feet (1.8 m) of chemical bath tanks in electrolysis areas.
 2. Laboratory receptacles within 6 feet (1.8 m) of the sink, including sinks inside fume hood enclosures.
 3. Out-door electrical receptacles with weatherproof enclosure/protection.
 4. Receptacles within six feet of an emergency eye wash/shower.
 5. Receptacle feeding water cooler units and drinking fountains
 - .15 Permanently and effectively ground wiring devices in accordance with Division 26 Section "Secondary Grounding for Electrical Systems".

END OF SECTION

1. General

1.1 RELATED DOCUMENTS

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- .1 Section Includes:
 - .1 Cartridge fuses rated 600-V ac and less for use in enclosed switches and enclosed controllers.
 - .2 Spare-fuse cabinets.

1.3 SUBMITTALS

- .1 Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
 - .1 Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - .2 Current-limitation curves for fuses with current-limiting characteristics.
 - .3 Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
 - .4 Coordination charts and tables and related data.
- .2 Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - .1 Ambient temperature adjustment information.
 - .2 Current-limitation curves for fuses with current-limiting characteristics.
 - .3 Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
 - .4 Coordination charts and tables and related data.

1.4 QUALITY ASSURANCE

- .1 Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- .2 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- .3 Comply with NEMA FU 1 for cartridge fuses.
- .4 Comply with NFPA 70.

1.5 COORDINATION

- .1 Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.6 EXTRA MATERIALS

- .1 Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- .2 Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than

three of each size and type.

2. Products

2.1 MANUFACTURERS

- .1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - .1 Cooper Bussmann, Inc.
 - .2 Ferraz Shawmut, Inc.
 - .3 Littelfuse, Inc.

2.2 CARTRIDGE FUSES

- .1 Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

3. Execution

3.1 EXAMINATION

- .1 Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- .2 Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- .3 Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- .4 Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- .5 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- .1 Cartridge Fuses:
 - .1 Service Entrance: Class RK1, time delay.
 - .2 Feeders: Class RK1, time delay.
 - .3 Motor Branch Circuits: Class RK1, time delay.
 - .4 Other Branch Circuits: Class RK1, time delay.
 - .5 Control Circuits: Class CC, fast acting.

3.3 INSTALLATION

- .1 Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

- .1 Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

1. General

1.1 SUMMARY

- .1 Related Documents:
 - .1 Drawings and general provisions of the Subcontract apply to this Section.
 - .2 Review these documents for coordination with additional requirements and information that apply to work under this Section.
- .2 Section Includes:
 - .1 Enclosed molded case circuit breakers.
- .3 Related Sections:
 - .1 Division 01 Section "General Requirements."
 - .2 Division 01 Section "Special Procedures."
 - .3 Division 01 Section "Common Work Results for Electrical".
 - .4 Division 26 Section "Secondary Grounding for Electrical Systems".

1.2 REFERENCES

- .1 General:
 - .1 The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
 - .2 Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.
 - .3 Refer to Division 01 Section "General Requirements" for the list of applicable regulatory requirements.
 - .4 Refer to Division 26 Section "Common Results for Electrical" for codes and standards, and other general requirements.
- .2 ANSI/NFPA 70 - National Electrical Code.
- .3 NFPA – National Fire Protection Association:
 - .1 Standard for Electrical Safety in the Workplace (NFPA 70E & Worksafe BC)
- .4 NEMA – National Electrical Manufacturers Association:
 - .1 NEMA 250 Enclosures for Electrical Equipment
 - .2 NEMA AB1 Molded Case Circuit Breakers
- .5 UL – Underwriters' Laboratories:
 - .1 UL 489 Molded Case Circuit Breakers and Enclosures.

1.3 SUBMITTALS

- .1 Submit under provisions of Division 26 Section "Common Results for Electrical - Review of Materials" and Division 01 Section "General Requirements."
- .2 Submit five (5) copies of Product Data and Shop Drawings for equipment and component devices. Include time–current curves of circuit breaker trip units.
 - .1 Include dimensional outline drawings; conduit entrance locations and requirements; voltage rating, continuous and short-circuit current ratings; cable terminal sizes and temperature ratings.

- .3 Operation and Maintenance Data:
 - .1 Maintenance Data: Furnish five (5) copies of recommended maintenance procedures and intervals. Include spare parts data listing; source and current prices of replacement parts and supplies.
 - .2 2. Furnish Time–Current curves of circuit breaker trip units. Time–Current curves shall be first generation originals on full size 11 by 17 inches (280 by 432 mm) paper.

1.4 QUALITY ASSURANCE

- .1 Products shall be tested, approved and labeled/listed by Underwriters Laboratories, Inc., or by a nationally recognized testing laboratory (NRTL) as listed in Division 26 Specification "Common Work Results for Electrical."
- .2 Electrical equipment and materials shall be new and within one year of manufacture, complying with the latest codes and standards. No used, re-built, refurbished and/or re-manufactured electrical equipment and materials shall be furnished on this project.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver materials to site in unopened cartons or bundles as appropriate, clearly identified with manufacturer's name, Underwriter's or other approved label, grade or identifying number.
- .2 Handle in accordance with manufacturer's written instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

2. Products

2.1 MANUFACTURERS

- .1 Schneider
- .2 Eaton
- .3 Cutler-Hammer.
- .4 Siemens

2.2 MOLDED CASE PROTECTIVE DEVICES

- .1 Protective devices shall be molded case circuit breakers with inverse time and instantaneous tripping characteristics
- .2 Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be non-welding silver alloy and arc extinction shall be accomplished by means of arc chutes.
- .3 Circuit breakers shall have a minimum symmetrical interrupting capacity as indicated on the drawings.
- .4 Circuit breakers 15 to 100 ampere frame shall be provided with fixed thermal-magnetic trip units.
- .5 Circuit breakers 225 ampere frame and above shall be provided with field-changeable, field-adjustable thermal-magnetic trip units with inverse time-current characteristics. Trip mechanisms shall be provided with the following trips: [instantaneous] [long time] [short time].
- .6 Circuit breakers 400 ampere frame and above shall be provided with microprocessor-based RMS sensing trip units with features noted on the drawings. Trip mechanisms shall be provided with the following trips: [instantaneous] [long time pickup] [long time delay]

- [short time pickup] [short time delay] [I2t function] [ground fault pickup] [ground fault delay].
- .7 Circuit breakers for HVAC and refrigeration unit equipment shall be listed by UL as Type HCAR.

2.3 ACCESSORIES

- .1 Provide accessories as indicated on the Drawings.
- .2 Shunt Trip Device: Coil rated for 120/208 volts, AC.
- .3 Undervoltage Trip Device: Coil rated for 120 /208 volts, AC.
- .4 Auxiliary Contacts: Rated at 120/ 208 volts, AC, see dwg. for rating. Contacts on an auxiliary switch; operation is designated "a" if open when the main circuit breaker contacts are open and "b" if closed when the main circuit breaker contacts are closed.
- .5 Alarm Switch: Rated at 120/ 208 volts, AC, see dwg. for rating. Alarm switch shall operate upon the tripping of the circuit breaker. Contacts on an auxiliary switch; operation is designated "a" if open when the main circuit breaker contacts are open and "b" if closed when the main circuit breaker contacts are closed.
- .6 Auxiliary Switch: Rated at 120/ 208 volts, AC, see dwg. for rating. Switch shall be interlocked with the main circuit breaker contacts.
- .7 Electrical Operator: Rated for 120/ 208 volts, AC.
- .8 Neutral Bus, insulated from enclosure: See drawings for Ampere rating.

2.4 ENCLOSURES

- .1 Provide enclosures fabricated from [steel] [aluminum] [plastic] suitable for locations as indicated on the drawings and as described below:
- .1 NEMA 1 surface or flush-mounted general purpose enclosures intended for indoor use.
- .2 NEMA 12 dust-tight enclosures intended for indoor use to provide protection against circulating dust, falling dirt and dripping non-corrosive liquids.
- .3 NEMA 3R rain-tight enclosures intended for outdoor use in damp locations or to provide protection against rain.
- .4 NEMA 4/4X watertight stainless steel intended for indoor or outdoor use to provide protection against windblown dust and rain, splashing rain, hose-directed water, and damage from corrosive agents
- .5 NEMA 7, Class I, Group C and D hazardous location cast aluminum intended for indoor use in locations classified as Class I, Group C and D as defined in the National Electrical Code
- .6 NEMA 9, Class II, Groups E, F and G hazardous location cast aluminum intended for indoor use in locations classified as Class II, Groups E, F and G as defined in the National Electrical Code
- .2 Provide a factory installed ground termination block sized for the grounding conductor indicated on the Drawings.
- .3 Provide operator handle mechanisms that are padlockable in the "OFF" position. In the case of electrically operated breakers, provide a permanently installed device for padlocking in the "OFF" position.
- .4 All enclosed circuit breakers shall have nameplates that contain a permanent record of catalog number and maximum rating.
- .5 Enclosures shall be finished using the manufacturer's standard process and shall be ANSI 61 gray color.

3. Execution

3.1 INSTALLATION

- .1 Install circuit breaker enclosures plumb with suitable supports and per manufacturer's recommendations. Where mounted on concrete wall, install with 1/2 inch (13 mm) steel spacers behind the switch enclosure. Mounting attachments and connections shall be designed in conformance with the minimum lateral seismic force of 0.5W per CBC.
- .2 Height: Install top of circuit breaker enclosure 78 inches (1980 mm) above finished floor, unless otherwise noted on drawings.
- .3 Provide engraved nameplates with the designation indicated on the Drawings.
- .4 Perform field adjustments of the circuit breakers as required to place the equipment in final operating condition. The settings shall be in accordance with the approved protective device coordination study or as directed by the Project Manager.

3.2 FIELD QUALITY CONTROL

- .1 Comply with requirements of NETA Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems and the manufacturer's inspection, testing, calibration and start-up procedures. The manufacturer's technician shall perform inspection, testing, calibration and start-up, with assistance from the Subcontractor as necessary, and in the presence of the University's representative. Schedule testing and start-up with at least ten (10) working days advance written notification.
- .2 Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and check tightness of connections with a calibrated torque wrench.
- .3 Electrical Tests: Measure and record insulation resistance of the enclosed circuit breaker and its components (phase-to-phase and phase-to-ground) prior to energization. The Subcontractor shall not be responsible for defective insulation in equipment that has been supplied by the University, unless such damage is due to negligence or incorrect handling or installation workmanship of the Subcontractor.
 - .1 The insulation resistance of each circuit phase-to-phase and phase-to-ground shall be measured. For circuits rated less than 600 volts, the resistance shall not be less than 100 megohms.
 - .2 Systems rated above 240 volts shall be tested with a 1000-volt Megohmmeter. Circuits rated 240 volts and below shall be tested with a 500-volt Megohmmeter. The D.C. potential shall be applied for thirty (30) seconds.
 - .3 Test and record phase rotation (clockwise) and sequence (A-B-C).
- .4 Provide the University with five (5) certified copies of field test reports.

END OF SECTION

1. General

1.1 SECTION INCLUDES

- .1 Equipment, fabrication and installation for ground fault protection.
- .2 See Section 26 23 00 - Low Voltage Switchgear.
- .3 See Section 26 24 02 - Service Entrance Board.

1.2 RELATED SECTIONS

- .1 Section 01 29 83 - Payment Procedures for Testing Laboratory Services.
- .2 Section 01 33 00 - Submittal Procedures.
- .3 Section 01 45 00 - Quality Control.
- .4 Section 01 91 13 – General Commissioning (Cx) Requirements.
- .5 Section 26 05 00 – Common Work Results - Electrical.

1.3 PAYMENT PROCEDURES

- .1 Pay for field testing of ground fault equipment performed by equipment manufacturer.

1.4 REFERENCES

- .1 Canadian Standards Association (CSA)
- .2 CAN/CSA-C22.2 No. 144, Ground Fault Circuit Interrupters.
- .3 National Electrical Manufacturers Association (NEMA)
- .4 NEMA PG 2.2, Application Guide for Ground Fault Protection Devices for Equipment.

1.5 SUBMITTALS

- .1 Submit product data and shop drawings.
- .2 Submit test report for field testing of ground fault equipment to Departmental Representative and certificate that system as installed meets criteria specified.

2. Products

2.1 EQUIPMENT

- .1 Ground fault protective equipment: components of one manufacturer.
- .2 Provide ground fault protection on 1000A, 600V, 4 wire, 3 phase service and 2000 A, 208V, 4 wire, 3 phase service and above: to NEMA PG 2.2 and CAN/CSA-C22.2 No. 144.
- .3 Ground fault unit to contain:
 - .1 Ground sensing relay suitable for operation at 500 mA as indicated on electrical drawings. Control voltage: 120 V.
 - .2 Ammeter with scale 0 to 5 A to indicate ground current value.
 - .3 Three position sensitivity control switch to select value of leakage current at which relay will operate.
 - .4 Indicating lamp illuminated when no ground fault exists, extinguished on ground fault or test.
 - .5 Switch:
 - .1 SPDT contacts for alarm and trip.
 - .2 Mechanical target indication.
 - .3 Manually reset.
 - .6 Reset button for contacts and target.
 - .7 Suitable for panel mounting.

- .4 Zero sequence transformer toroidal type with 300 - 3000 mA range.
- .5 Neutral:
 - .1 Use an artificial neutral and grounding resistor.
 - .2 Use neutral ground resistor unit.
- .6 System to operate instantaneously at ground current setting.

2.2 FABRICATION

- .1 Install following components in equipment specified in other Sections and as indicated.
 - .1 Zero sequence transformer.
 - .2 Ground fault relay.
 - .3 Ground resistor unit.

2.3 RELATED EQUIPMENT

- .1 Shunt trip breakers. Load break disconnect switch.

3. Execution

3.1 INSTALLATION

- .1 Do not ground neutral on load side of sensor.
- .2 Install phase conductors including neutral through zero sequence transformer.
- .3 Install ground fault protection system.
- .4 Make connections as indicated and in accordance with manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 – Common Work Results - Electrical and Section 01 91 13 – General Commissioning (Cx) Requirements.
- .2 Arrange and pay for field testing of ground fault equipment by ground fault equipment manufacturer before commissioning service.
- .3 Check trip unit settings to ensure proper working operation and protection of components.
- .4 Demonstrate simulated ground fault tests.

END OF SECTION

1. General

1.1 RELATED IN SPECIFIED IN OTHER SECTIONS

- | | | |
|----|-------------------------------|------------------|
| .1 | General Requirements | Division 1 |
| .2 | General Electrical Provisions | Section 26 05 01 |
| .3 | Main Distribution Equipment | Section 26 24 13 |
| .4 | Panelboards | Section 26 24 17 |

1.2 REGULATORY REQUIREMENTS

- .1 Units to list CSA approval.
- .2 Size with voltage, current and interrupting capacities required by the Canadian Electrical Code.

2. Products

2.1 MOULDED CASE BREAKERS

- .1 Moulded case automatic circuit breakers: 600 and 250 volt bolt-in type with thermal and magnetic trip, quick make/ quick break type, trip free position separate from "On" or "Off" positions, for manual and automatic operation, interrupting rating minimum 10 kA or as indicated in panel schedules or as required for application. Common trip breakers shall have single handle for multi-pole applications. Wafer or duplex type breakers will not be accepted. Width of breaker to be minimum 25 mm per pole.
- .2 Ground fault Interrupting Breakers: As above with 5 mA or 30 mA leakage trip to suite application. All heat trace circuits to be installed with 30 mA trip. Install ground fault protection as indicated on drawings and at breakers required by the CEC

2.2 ENCLOSURES

- .1 Where separately mounted outside equipment, to be CSA Type 1 or 2 in dry, heated areas, EEMAC Type 3 in outdoor locations, and EEMAC Type 4 in corrosive atmosphere.

3. Execution

3.1 INSTALLATION

- .1 Install disconnect switches as required by the CEC and as indicated on the drawings. All motors shall have a disconnect installed at the motor. Remote disconnect such as breakers are not acceptable.
- .2 Factory install breakers in panel boards in size and quantity indicate on the panel boards schedules.
- .3 Install correct type and size of fuse in fused disconnects.

END OF SECTION

1. General

1.1 DESCRIPTION

- .1 Provide disconnect switches for 120/208 volt distribution as indicated on the drawings, as manufactured by Schneider, Cutler Hammer, Siemens & Eaton.
- .2 Disconnects to be to CAN/CSA C22.2 No. 4-M89 and required by CEC to suit application.

2. Products

2.1 DISCONNECT SWITCHES

- .1 Ratings: 600/240 volts for 120/208-volt distribution. Unless otherwise shown, 3 pole for 3 phase, 3 wire distribution, 3 pole and solid neutral for 3 phase 4 wire distribution. Ampere ratings as shown on the drawings or to suit load requirements. For motors, use disconnect switches with HP ratings at least equal to motor HP.
- .2 Enclosures: CSA code gauge galvanized steel, hinged doors, external operating handles. Disconnect switches in dry locations shall be EEMAC-2 and EEMAC-3 where exposed to weather.
- .3 Finish: One primer coat and one finish coat on all metal surfaces, colours as per Section 26 05 01.
- .4 Switch mechanisms: Quick make and quick break action with self wiping contacts, solderless pressure lug connectors. For switches 100 amperes and over, provide non-tracking arc shrouds. All switch poles to operate together from a common operating bar. Provide for padlocking disconnect switches in "Off" position. Doors to be interlocked and complete with defeat mechanism.
- .5 Neutral Bars: Where distribution system has grounded neutral conductor, provide neutral bar where required with ampere rating equal to switch rating, in enclosure. Provide ground bar for terminating ground conductors.
- .6 Fuse Holders: Provide fuse holders on load side of switches, ampere rating equal to switch ratings, suitable for fuses specified.

2.2 FUSES

- .1 All fuses to be 100,000 ampere (minimum) interrupting capacity of the current limited type. In addition, fuses feeding motors to be of the time delay type. Provide one full set of spare fuses, three for each different ampere rating used, stored in suitable enclosure.

3. Execution

3.1 DISCONNECT SWITCHES

- .1 Mounting: Provide supports independent of conduits. Wall mount where possible, otherwise, provide Unistrut frame support. Where switches are grouped mount in uniform arrangement.
- .2 Wiring: Connect line and load cable to all switches.
- .3 Fuse Rating: Install so that the rating is visible.

- .4 Identification: Provide lamaroid plate on each switch showing voltage, source of supply and load being fed, for example:

Door Controller
120/208 Volts
Fed from PPA
- .5 Install disconnect switches complete with fuses as indicated on drawings.

END OF SECTION

1. General

1.1 RELATEDWORK

- .1 Mechanical

1.2 WORKINCLUDED

- .1 Installation of Variable Speed Drives to be completed by this Division as per mechanical specifications.
- .2 The system shall be complete and shall include all components necessary to comprise as a functional system.

1.3 RELATEDWORK BY OTHERS

- .1 Mechanical Contractor to supply Variable Speed Drives as per mechanical specifications.

2. Products

- .1 Not used

3. Execution

3.1 GENERAL

- .1 The Mechanical Contractor shall provide the VFD manufacturer a shop drawing of each motor application, to ensure that VFD(s) and motors are fully compatible.
- .2 Motor application data are shown on the mechanical drawings / specifications.

3.2 INSTALLATION

- .1 Electrical Contractor to install VFD(s), filters, and associated equipment in locations as indicated on drawings, and cooperate with Division 23 regarding connecting up all necessary wiring.

END OF SECTION

1. General

1.1 RELATED WORK

- | | | |
|----|---|------------------|
| .1 | General Electrical Requirements | Section 26 05 01 |
| .2 | Luminaire Schedule (Unless on drawings) | Section 26 51 00 |
| .3 | Exit Lights | Section 26 53 00 |

1.2 WORK INCLUDED

- .1 This section includes for the supply and installation of luminaires complete with lamps, driver, supports and accessories, and for the supply of plaster frames, trim rings and back boxes for plaster or dry wall ceilings or concrete.

1.3 CODE REQUIREMENTS

- .1 Installation of lighting equipment to conform to the current edition of the Canadian Electrical Code as amended and supplemented by provincial, municipal or other regulatory agencies having jurisdiction.
- .2 Luminaires to conform to CSA C22.2 No. 9, ANSI C82.1 and lamps to ANSI C78. LED drivers with ENEC mark and EMC tested, IP20 for indoor and IP65 for outdoor

1.4 COORDINATION WITH OTHER DIVISIONS

- .1 Confirm compatibility and interface of other materials with luminaire and ceiling system. Report discrepancies to the A/E and defer ordering until clarified.
- .2 Supply plaster frames, trim rings and back boxes to other trades as the work requires.
- .3 Coordinate with other trades to avoid conflicts between luminaires, supports and fittings and mechanical or structural building elements.

1.5 SHOP DRAWINGS

- .1 Submit a complete list of the types of lighting luminaires, lamps, ballasts and accessories with catalogue illustrations, data sheets, etc., for review.
- .2 Submit complete photometric data based on actual luminaires proposed for the project. Photometric data must be produced by an independent testing laboratory.

1.6 SAMPLES

- .1 Provide samples of luminaires, lamps, drivers and accessories when requested by the A/E.

2. Products

2.1 GENERAL

- .1 Provide, wherever possible, commercially available luminaires meeting the specified requirements and as indicated on the drawings. Different luminaires may be supplied by different manufacturers. Similar luminaires shall be supplied by the same manufacturer.
- .2 It is Contractors responsibility to perform all NECB calculation and get approvals from City if different fixture is utilized. Submit alternate specification to PCA Departmental Representative prior to tender close. Alternate specifications are only valid with PCA Departmental Representative written approval.
Alternates specifications are not allowed for exterior luminaires. Provide as per Specifications on the drawings.

Recessed pot-lights shall be of the pre-wired type with the junction box and, where applicable, the ballast forming an integral part of the assembly with satisfactory access. Unit shall be complete with plaster rings and supports as required. Ballasts
- .3 Provide only luminaires which are structurally well designed and constructed and which use new materials of the highest commercial grade available. Unless specifically noted otherwise, luminaires to be of the quality stated in the manufacturers catalogues and data sheets. Luminaires shall be designed for adequate dissipation of ballast and lamp heat.
- .4 Louvres shall be supplied by this division and shall be acrylic with finish as specified or as selected by PCA Departmental Representative.
- .5 Use self-aligning ball joint hangers for stem suspended luminaires.
- .6 Use cadmium plated chains for suspended luminaires in unfinished areas.
- .7 Supply and install aligning channels for mounting suspended continuous row luminaires.

2.2 LED LUMINAIRES

- .1 Light Emitting Diodes (LED)
 - .1 CRI shall be greater than or equal to 75.
 - .2 Rated LED life time shall demonstrate 70% lumen maintenance at 35,000 hours as defined in the IESNA standards.
 - .3 LED's shall be IES LM-79 and LM-80 tested and certified.
- .2 LED Drivers (Electronic- Instant Start)
 - .1 Drivers shall comply with ANSI C62.41 Category A for Transient protection.
 - .2 Driver to be compliant with ROHS.
 - .3 Driver to be EMI compliant in accordance with FCC 47 Sub Part 15, CISPR 15, CISPR 22 Class A, EN61000-3-2, -3-3, -4-4, -4-5.
 - .4 Driver to be compliant with Safety regulations in accordance with UL879, UL1012, UL935, IEC61347-2-2, EN61558-1, EN61558-2-17, EN60065, IEC6100-4-5.
 - .5 Drivers shall contain no PCB's nor mercury.
 - .6 Drivers shall be primary fused.
 - .7 Output ripple maximum 10%
 - .8 Temperature: -40 to +80 degree Celsius for exterior luminaires, 0 to +80 degree Celsius for interior luminaires,
 - .9 Efficiency minimum 93%.
 - .10 Power factor >0.9 at full load.
 - .11 Input 120V
 - .12 Output 120 – 425 VDC, 0.35Amp ±5%.
 - .13 Frequency 50-60 Herz.
 - .14 Total Harmonic Distortion < 10% at Full Load at 120 Volt and <15% at 347 Volt.
 - .15 Driver to be fully encased and potted.
 - .16 Life time rated at minimum 50,000 hours.

3. Execution

3.1 INSTALLATION

- .1 Install recessed luminaires to permit removal from below to gain access to outlet or pre-wired luminaire box. Make final connection from boxes to luminaires with flexible conduit. AC-90 (with No. 14 AWG conductors) may be used but shall be independently supported, (e.g., not from the connectors), and have anti-shorts installed. With either type of connection method, the length of the flexible connection shall not exceed 2 meters.
- .2 For recessed luminaires in particular for HID pot-lights and fluorescent luminaires, support luminaire independent of suspended ceiling system.
- .3 Where luminaires are surface-mounted on T-bar ceilings, support unit from structure and stabilize luminaire with sheet metal screws into a T-bar at both ends.
- .4 When luminaires are installed in valances with solid lens, ensure presence of adequate ventilation openings into ceiling space to dissipate heat.

3.2 WORKMANSHIP

- .1 Completely clean all luminaires, including lenses, lamps, hangers and interiors at completion of project and before final acceptance of project.
- .2 Provide suitable extension couplings for wall mounted luminaires.
- .3 Hang and mount luminaires to prevent distorting frame, housing, sides or lens frame and permit correct alignment of several luminaires in a row.
- .4 Support luminaires as indicated on the drawings, level and plumb and true with structure and other equipment in horizontal or vertical position as intended. Install wall or side bracket mounted luminaire housings rigidly and adjust to a neat flush fit with mounting surface.
- .5 Install ceiling canopies to cover suspension attachments and fit tightly to ceiling without restricting alignment of hanger.
- .6 Where luminaires are required to be supported from the building structure, use a minimum of 2 - 6.35 mm rods per luminaire.
- .7 For remotely mounted ballasts, supply mounting boards and space ballasts in accordance with manufacturer's direction. Size wiring from ballast to remote luminaires to meet manufacturer's requirements.
- .8 Remove any noisy ballasts from the luminaires and replace at no additional cost to the Owner prior to completion and final acceptance of the installation.
- .9 Coordinate entire installation with other trades prior to rough stage on site to avoid conflicts. During installation, locate ductwork and any other items that may cause interference in the ceiling space. Notify general contractor M and E coordinator promptly of any conflicts.
- .10 In mechanical rooms and areas install lighting after piping and ductwork is installed to permit final light locations to be determined. Allow for additional necessary chain, hanger
- .11 rods and supports as may be necessary.

3.3 BRANCH CIRCUIT WIRING

- .1 Where the drawings do not show conduit routing or conduit sizes and wire counts, supply and install a complete system of conduit and wire for the lighting system. Make all connections and install all conductors for the switching and branch circuiting indicated and required. Run conduit parallel to major building lines.
- .2 Conductors shall be #12 R90 x-link minimum.
- .3 Conduits shall be sized in accordance with code requirements for the wire count installed. In no case shall conduit less than 21 mm be used for home runs. Base conduit fill on maximum of six phase conductors per conduit, resulting in a derating of 80% as per CEC 4-004 (1) (C).
- .4 Special lamps not specified in this Section to be as called for in the Luminaire Schedule.
- .5 All lamps supplied to be suitable for luminaire burning position.

3.4 LUMINAIRE ALIGNMENT AND CLEANING

- .1 Align luminaires in continuous rows to form straight uninterrupted line.
- .2 Align individual mounted luminaires parallel or perpendicular to building lines.
- .3 Thoroughly clean all fixtures, including reflectors , lamps diffusers louvers and lenses.
- .4 Adjust lenses, frames and trims to eliminate light leaks.

3.5 LUMINAIRE SUPPORTS

- .1 For suspended ceiling installations support luminaires from ceiling grid in accordance with local inspection requirements.
- .2 Install blocking behind drywall mounted fixtures to support luminaire. Do not mount fixture to drywall with inserts or toggle bolts.
- .3 Fixtures surface mounted on t-bar shall be support with approved t-bar clips.
- .4 Support fixtures in T-Bar tiles with 13 by 38 mm channel supports that are tied to the ceiling support system.
- .5 Combustible materials such as wood blocking may not be used in ceiling spaces to support fixtures or electrical items.

END OF SECTION

1. General

1.1 WORK INCLUDED

- .1 Supply emergency lighting units complete with all accessories.

1.2 SPECIAL CODES

- .1 Canadian Electric Code, Part 1, Section 46 "Emergency Systems, Unit Equipment and Exit Signs".
- .2 CSA Standard C22.2 No. 141-M1985 "Unit Equipment for Emergency Lighting".
- .3 National Building Code and BC Building Code.

2. Products

2.1 GENERAL

- .1 Supply and install battery power emergency lighting where shown on the drawings. Lights are to switch "ON" automatically in the event of failure of normal power, and "OFF" on restoration of power. The batteries shall be automatically recharged from a 120 VAC supply, Output Voltage 24 V.

2.2 LINE CONNECTION

- .1 Each battery unit shall be equipped with AC line cord and plug.

2.3 UNITS

- .1 Units to contain solid state battery charger, transfer switch and batteries. Provide all relays, hardware and circuitry for operation specified. Units to have push-to-test switch, "ON" and "charging" lights with extended lamp life and be complete with automatic self diagnostic circuitry.

2.4 BATTERIES

- .1 Unless specifically indicated, of sufficient watt-hour capacity to power the loads connected to each individual unit for 30 minutes, 12 volt, 10 year long life sealed lead acid batteries, contained within the units.
- .2 DC Power: Flexible conduit to be an electrical box.

2.5 HEADS

- .1 Remote and/or integral lighting heads to be as shown on drawings. Fixtures to be adjustable 4W/24V LED MR16 type.
- .2 Wire guards to be installed on all remote heads in the locker rooms and gymnasiums.

2.6 MOUNTING BRACKET

- .1 Metal Shelf type, specifically made for unit supplied.

2.7 MANUFACTURER

- .1 Stanpro see drawings for model no. & wattage information complete with mounting bracket and automatic self Diagnostic circuitry. Other approved manufacturers: Emergi-Lite, Ready-Lite, Dual-Lite, Aim Lite.

2.8 LOW VOLTAGE DISCONNECT

- .1 To disconnect battery on drop in voltage at a level which will damage the battery permanently, i.e. below 85% of nominal voltage.

3. Execution

3.1 INSTALLATION

- .1 Mount battery units with the bottom of the enclosure not less than 2.2 m above the floor, where practicable.
- .2 Install duplex receptacle adjacent to unit and connect to 1Ø 120V unswitched area lighting circuit.
- .3 Where applicable wire from unit to DC circuitry in exit lights.
- .4 Wiring from units to remote heads and/or exit lights shall be sized to prevent voltage drop of more than 5%.

END OF SECTION

1. General

1.1 RELATEDWORK

- | | | |
|----|---|------------------|
| .1 | General Electrical Requirements | Section 26 05 01 |
| .2 | Lighting Equipment | Section 26 50 00 |
| .3 | Luminaire Schedule (unless on drawings) | Section 26 51 00 |
| .4 | Unit Equipment for Emergency Lighting | Section 26 52 00 |
| .5 | Canadian Standards Association (CSA)
CSA C22.2 No.141, Unit Equipment for
Emergency Lighting.
CSA C860, Performance of Internally-Lighted Exit
Signs.

NFPA 101, Life Safety Code | |

1.2 WORK INCLUDED

- .1 Supply exit lights suitable for mounting as indicated, with lamps and accessories.
- .2 Provide heavy duty substantial wire guards on all exit lights in gymnasium.

1.3 CODE REQUIREMENTS

- .1 Canadian Electrical Code, Part 1, Section 46, Emergency Systems, Unit Equipment and Exit Signs.

2. Products

2.1 LUMINAIRES

- .1 Manufacture: Stanpro as shown on drawings or approved equals. Other approved manufacturers: Ready-Lite, Emergi-Lite., Lithonia, Aim lite
- .2 General Construction: Extruded aluminum faceplates, white finish, with letters cut through to expose fiberglass diffusers, with directional arrows as indicated on drawings. The LED sign shall consume less than five watts per face and shall have solid state design.
- .3 Mounting: End to wall, wall or ceiling, single or double sides as indicated. Multiple knock-outs for universal mounting not acceptable.
- .4 Units to be complete with integral battery and electronic components to allow for AC to DC automatic transfer. Battery to be rated for 10-year life and unit to be complete with self and manual test.
- .5 Provide heavy duty substantial wireguards on exit lights located in gymnasium.

2.2 STANDARD UNITS

- .1 Exit lights: to CSA C22.2 No.141 and CSA C860, packaged in accordance with the Canadian Electrical Code for Preferred Packaging guidelines.

- .2 Housing: cold rolled steel minimum 1.0 mm thick, satin aluminum enamel finish
- .3 Face and back plates: extruded aluminum.
- .4 Lamps: multiple - LED-4 W, 120 V, over 500,000 hours with average surface brightness of 3000 candela.
- .5 Operation: designed for 25 years of continuous operation without relamping.
- .6 Letters: 150 mm high x 19 mm, with 13 mm thick stroke red on extruded aluminum face, reading EXIT.
- .7 Downlight: white glass in bottom of unit.
- .8 Third lamp socket for emergency lamp lighting circuit.
- .9 Face plate to remain captive for relamping.

2.3 SELF-POWERED UNITS

- .1 Exit lights: to CSA C22.2 No.141 and CSA C860, packaged in accordance with the Canadian Code for Preferred Packaging guidelines.
- .2 Housing: cold rolled steel minimum 1.0 mm thick, satin aluminum enamel finish.
- .3 Face and back plates: extruded aluminum.
- .4 Lamps: multiple -, LED-12W 120 V over 500,000 hours.
- .5 Operation: designed for 25 years of continuous operation without relamping.
- .6 Letters: 150 mm high x 19 mm wide, with 13 mm thick stroke, red on extruded aluminum face, reading EXIT.
- .7 Downlight: white glass in bottom of unit.
- .8 Third lamp socket for emergency lamp lighting circuit.
- .9 Face plate to remain captive for relamping.
- .10 Supply voltage: 120 V, ac.
- .11 Output voltage: 12 or 24 V dc.
- .12 Operating time: minimum 30 minutes and as required by code.
- .13 Recharge time: 12 hours
- .14 Battery: sealed, maintenance free, warranty to Section 26 52 00 – Emergency Lighting, 1.5 – Emergency Lights.
- .15 Charger: solid state, voltage/current regulated, inverse temperature compensated, short circuit protected, with regulated output of plus or minus 0.01 V for plus or minus 10% V input variation.
- .16 Solid state transfer circuit.
- .17 Signal lights: solid state, for 'AC Power ON'.
- .18 Lamp heads: integral on unit, 345° horizontal and 180° vertical adjustment. Lamp type: as indicated.
- .19 Mounting: suitable for universal mounting directly on junction box and c/w knockouts for conduit. Removable or hinged front panel for easy access to batteries.
- .20 Cabinet: finish: standard.
- .21 Auxiliary equipment:
 - .1 Lamp disconnect switch.
 - .2 Test switch.
 - .3 AC/DC output terminal blocks inside cabinet.
 - .4 RFI suppressor.
 - .5 Cord and single twist-lock plug connection for AC power supply.

2.4 DESIGN X1

- .1 Recessed, wall, end to wall, ceiling mounting as indicated.
- .2 Single or double face with running man pictogram face plate to remain captive for relamping as indicated.

- .3 Arrow: right or left as indicated.
- .4 Wireguard

3. Execution

3.1 INSTALLATION

- .1 Install exit lights to manufacturer's recommendations, listing requirements, NFPA standard and local regulatory requirements.
- .2 Connect fixtures to exit light circuits using RW90 wire in EMT conduit.
- .3 Connect emergency lamp sockets to emergency circuits.
- .4 Ensure that exit light circuit breaker is locked in on position.
- .5 Provide tests in accordance with Section 26 05 00 – Common Work Results - Electrical and Section 01 91 13 – General Commissioning (Cx) Requirements.
- .6 Connect exit lights to separate branch circuits and to emergency battery packs as indicated. Provide red bolt on breaker for exit sign and Identify circuit breakers feeding exit light circuits and install locking straps.

3.2 CLEANING

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.
- .3 PVC conduit shall not be used with wiring for exit lights unless embedded in concrete or block wall.
- .4 Install exit lights on ceiling's only when not possible to wall mount. Install 6inch below ceiling level.

END OF SECTION

1. General

1.1 RELATED SECTIONS

.1	Identification	Section 26 05 53
.2	Conduits	Section 26 05 33
.3	Cable Trays	Section 26 05 36
.4	Outlet Boxes, Pull Boxes, Cabinets and Miscellaneous Raceways	Section 26 05 32
.5	Wiring Devices	Section 26 27 26
.6	Hangers, Supports and Inserts	Section 26 05 29
.7	Low Voltage Communication Raceway System	Section 27 05 28

1.2 SYSTEM DESCRIPTION

- .1 Structured telecommunications wiring system consist of unshielded-twisted-pair and optical fiber cables, terminations, connectors, cross-connection hardware and related equipment installed inside building for occupant's telecommunications systems, including voice (telephone), data. Conduit, cabling and outlets to form a complete and operating Category 6 horizontal cabling system for data and telephone as indicated on the drawings and detailed in this specification.
- .2 Provide all cabling and associated components as described in the specifications and drawings.
- .3 Cable system shall have end-to-end Category 6 rated products with components manufactured by a single manufacturer.
- .4 Approved manufacturers are: AMP, Belden, Systimax, Leviton and Panduit.
- .5 Install voice and data backbone cables in conduit as indicated on the drawings. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure.
- .6 Backbone cabling systems consists of backbone cables, intermediate & main cross-connects and mechanical terminations.
- .7 The communication cabling system shall be supplied and installed as a sub-contract to Division 26 – Electrical.

1.3 REFERENCES

- .1 The following industry standards are the basis for the structured cabling system described in this document
- .2 Canadian Standards Association (CSA International)
 - .1 C22.2 NO. 214-08 – Communications cables (Bi-national standard, with UL 444)

- .2 C22.2 NO. 232-09 – Optical fiber cables
- .3 CAN/CSA C22.1-06 – Canadian Electrical Code.
- .3 Telecommunications Industry Association (TIA)/Electronic Industries Alliance (EIA)
 - .1 ANSI/TIA-568-C.1–2009+A1:2012, Commercial Building Telecommunications Cabling Standard
 - .2 ANSI/TIA-568-C.2–2009+A1:2010, Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
 - .3 ANSI/TIA-568–C.3–2009+A1:2011, Optical Fiber Cabling Components Standard
 - .4 ANSI/TIA-568–C.4–2011, Broadband Coaxial Cabling and Components Standard
 - .5 ANSI/TIA-569-C–2012, Telecommunications Pathways and Spaces
 - .6 ANSI/TIA/EIA–598–C–2005, Optical Fiber Cable Color Coding
 - .7 ANSI/TIA–606–B–2012, Administration Standard for Commercial Telecommunications
 - .8 ANSI/TIA–607–B–2011, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 - .9 ANSI/TIA–758–B–2012, Customer-Owned Outside Plant Telecommunications Infrastructure Standard
 - .10 ANSI/TIA–862–A–2011, Building Automation Systems Cabling Standard
 - .11 ANSI/TIA–942–A–2012, Telecommunications Infrastructure Standard for Data Centers.
 - .12 ANSI/TIA–1152–2009, Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
 - .13 NFPA
 - .1 NFPA 70 National Electric Code (NEC)
 - .14 ISO/IEC
 - .1 ISO 11801 Generic Cabling for Customer Premises
- .4 If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.
- .5 This document does not replace any code, either partially or wholly. The contractor must be aware of local codes that may impact this project.

1.4 SUBMITTALS

- .1 Prior to start of work the contractor shall submit copies of the certification of the company and names of staff that will be performing the installation and termination of the installation to provide proof compliance of this specification. The contractor shall employ a Registered Communication Distribution Designer who has current RCDD membership with BICSI.
- .2 Submit appropriate cut sheets and samples of all products, hardware and cabling.
- .3 Do not start any part of the telecommunications system installation until approval for all system shop drawings have been approved. Installer is to confirm pathways from outlet to rack will accommodate maximum cable length including service lops prior to materials arriving on site

- .4 The Contractor shall receive approval from the Owners on all substitutions of material. No substituted materials shall be installed except by written approval from the Owner.

1.5 QUALITY ASSURANCE

- .1 The Contractor shall provide a complete warranty to guarantee a high performance cabling systems that meet application requirements. The guarantee shall include all cable installed in the structured cabling system. The Cable shall be warranted for a period of at least 25 years.
- .2 The installing contractor shall submit proof that they are certified by the manufacturer of the system components to install and certify the system.

1.6 DRAWINGS

- .1 It shall be understood that the electrical details and drawings provided with the specification package are diagrammatic. They are included to show the intent of the specifications and to aid the contractor in bidding the job. The Contractor shall make allowance in the bid proposal to cover whatever work is required to comply with the intent of the plans and specifications. .
- .2 The telecommunications contractor shall verify all dimensions at the site and be responsible for their accuracy.
- .3 Prior to submitting the bid, the telecommunications contractor shall call the attention of the PCA Departmental Representative to any materials or apparatus the Contractor believes to be inadequate and to any necessary items of work omitted.

2. Products

2.1 HORIZONTAL DATACABLES

- .1 4 pair, Category 6 (CAT6) 23 AWG
- .2 Jacket colour – Blue FT 6 rated
- .3 The cable shall meet or exceed the requirements of ANSI/EIA/TIA 568-B-2.1.
- .4 The UTP-based cabling system shall use matched components from a single manufacturer, and the cabling system shall be certified to deliver system performance over the lifetime of the applications for which the cabling system was originally designed to support.

2.2 HORIZONTAL VOICE CABLE

- .1 4 pair, Category 6 (CAT6) 23 AWG UTP cable
- .2 Jacket colour – White FT6 rated
- .3 The cable shall meet or exceed the requirements of ANSI/EIT/TIA 568-B-2.1

- .4 The UTP-based cabling system shall use matched components from a single manufacturer, and the cabling system shall be certified to deliver system performance over the lifetime of the applications for which the cabling system was originally designed to support.

2.3 FIBER OPTIC BACKBONE CABLE

- .1 Fiber optic backbone cable to be a laser optimized 50/125 micron OM3 multi mode fiber surrounded by aramid strength members and a PVC outer jacket. Cable shall be tested to comply with ANSI/TIA-568-C.3. 12 strand Multi Mode Minimum from data room to each sub rack.
 - .1 Cable to have an FT6 compliant riser rated sheath.
 - .2 Terminate Fiber optic cable on rack mounted termination panels. Panels to come with integrated front trough with provisions for labeling and rear cable management bar.
 - .3 Fiber terminations to be Type SC . The optical fiber field-installable connector shall be field installable, without requiring epoxy or polishing.
 - .4 Terminate all fibers.
 - .5 Outdoor rated cable to be used for all inter-building pathways.
 - .6 Contractor shall supply and install a 12 strand MM fiber tie between each wiring closet/cabinet and main computer room location in the main communications room.
 - .7 Minimum bend radius Ten times the cable diameter or as per manufacturer's recommendation which ever is more stringent.

2.4 COPPER BACKBONE VOICE CABLE

- .1 Voice backbone to be a 25, 50 or 100 pair Cat 6 24 AWG, UTP, NEC/NFPA CMR rated and be independently verified for compliance. Cable shall meet or exceeds all TIA/EIA-568-A Category 5 and ISO 11801 Class D requirements.
- .2 Cable jacketing to be GRAY and shall be lead free. Cable shall be verified and characterized to 100 MHz Cable shall be supplied on reels.
- .3 Terminate cables on wall mounted IDC cross-connect systems. The wall mount frames shall be field terminated kits including all blocks, connecting blocks, and designationstrips.
- .4 Contractor shall supply and install a 50 pair CAT6 copper tie between demarcation locations to the main telephone room. Contractor shall supply and install a minimum of 25 pair Cat 6 copper tie between main telephone room and each wiring closets. Contractor may be required to increase cabling by 50 pair increments to ensure that a minimum 25% spare capacity exist when they confirm number of pair required to meet telephone requirements from each wiring closet.

2.5 CONNECTORS

- .1 Horizontal Data:
 - .1 Category 6 jacks.
 - .2 Telecommunication jacks shall be 8-position/8-conductor modular outlet accepting standard modular RJ45 type plugs and IDC terminations. Jacks shall have UL and CSA approval.
 - .3 Each modular jack shall be provided with a bend-limiting strain relief. The strain relief shall provide cylindrical support to limit the bend radius at the point of termination.

- .4 All terminations for this project shall use the T568A wiring scheme.
- .5 Colour – Blue
- .6 Horizontal Voice
- .1 Category 6 jacks.
- .2 Telecommunication jacks shall be 8-position/8-conductor modular outlet accepting standard modular RJ45 type plugs and IDC terminations. Jacks shall have UL and CSA approval.
- .3 Each modular jack shall be provided with a bend-limiting strain relief. The strain relief shall provide cylindrical support to limit the bend radius at the point of termination.
- .4 All terminations for this project shall use the T568A wiring scheme.
- .5 Colour – White

2.6 PATCH CORDS

- .1 Patch cords for interconnection of switches to patch panels supplied by Owner.

2.7 PATCH PANELS

- .1 Panels shall be available in 24 Port and 48 Port Configurations, with height of 1 RU (1.75 inches) for each group of 24.
- .2 Patch panel to come with removable rear mounted cable management bar front and rear identification labels.
- .3 Fiber patch panels to be 12 port panels with ST connectors at each termination point.

2.8 EQUIPMENT RACKS

- .1 Floor Mounted racks
 - .1 Racks to be 19" wide x 36" deep x 84" high, four posts, free standing equipment racks.. fabricated of 2.5 mm min painted steel., drilled and tapped both sides for No. 12 screws. Complete with grounding lug.
 - .2 Designed to accommodate standard width EIA 483 mm panels.
 - .3 Receptacle bar with 3m power cord , minimum 10 outlets complete with surge suppressor
 - .4 Refer to drawings for quantity and location.
 - .5 Equipment racks to be equal to Mid Atlantic R4 Series or equivalent.
- .2 Vertical Cable Management
 - .1 Panels shall protect network equipment by controlling cable bend radius and providing cable strain relief.
 - .2 The covers shall be able to hinge from either side yet still be easily removed to allow for quick moves, adds, and changes.
 - .3 Provide and install two (2) vertical cable management for each free standing rack.
 - .4 Vertical cable manager to be equal to Mid Atlantic DRCC-44 or equivalent.
- .3 Horizontal Cable Management
 - .1 Panels shall be a universal design mounting to EIA 19" racks and constructed of steel bases.

- .2 The covers shall be able to hinge from either side yet still be easily removed to allow for quick moves, adds, and changes.
- .3 Provide and install one (1) horizontal cable management for each patch panel.
- .4 Grounding and Bonding
 - .1 The facility shall be equipped with a Telecommunications Bonding Backbone (TBB). This backbone shall be used to ground all telecommunications cable shields, equipment, racks, cabinets, raceways, and other associated hardware that has the potential to act as a current carrying conductor. The TBB shall be installed independent of the building's electrical and building ground and shall be designed in accordance with the recommendations contained in the ANSI/TIA/EIA-607 Telecommunications Bonding and Grounding Standard.
 - .2 All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, etc., entering or residing in the TR or ER shall be grounded to the respective TGB or TMGB using a minimum #6 AWG stranded copper bonding conductor and compression connectors.
 - .3 All wires used for telecommunications grounding purposes shall be identified with a green or with a wrap of green tape insulation. Non-insulated wires shall be identified at each termination point with a wrap of green tape. All cables and busbars shall be identified and labeled in accordance with the System Documentation Section of this specification.
- .5 Firestop
 - .1 All penetrations through fire-rated building structures (wall and floors) shall be sealed with an appropriate firestop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure). Any penetrating item i.e., riser slots and sleeves, cables, conduit, cable tray, and raceways, etc. shall be properly firestopped.
 - .2 Firestop systems shall be UL Classified to ASTM E814 (UL 1479) and shall be approved by a qualified Professional Engineer (P.ENG.), licensed (Actual or reciprocal) in the Province where the work is to be performed. A drawing showing the proposed firestop system, stamped/embossed by the P.ENG. shall be provided to the Owner's Technical Representative prior to installing the firestop system (s).

3. Execution

3.1 INSTALLATION

- .1 shall be installed in accordance with manufacturer's recommendations and best industry practices.
- .2 A plastic or nylon pull cord with a minimum test rating of 90 kg (200lb.) shall be co-installed with all cable installed in any conduit.
- .3 Cables at equipment racks shall be neatly bundled with Velcro tie wraps.
- .4 All telecommunication and data wiring to be installed in cable trays and conduit as detailed on the drawings. Cable raceways shall not be filled greater than the ANSI/TIA/EIA-569-A maximum fill for the particular raceway type of 40%.
- .5 The cable's minimum bend radius and maximum pulling tension shall not be exceeded.

- .6 Do not exceed the maximum tensile strength rating of the cable when pulling into conduit or cable trays. Pulling tension on 4-pair UTP cables shall not exceed 25-lbf for a four-pair UTP cable.
- .7 Provide horizontal and vertical wire management accessories on the equipment racks to route incoming horizontal cables in an orderly manner.
- .8 At each equipment rack, provide 3 meter cable loop to allow for future rack relocation within the equipment room. Neatly tie cable loop to the equipment rack.
- .9 Cable may not be spliced. Secure and support cables at intervals not exceeding 30" and not more than 6" from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
- .10 Separation from EMI Sources:
 - .1 Comply with BICSI TDMM and TIA / EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources including electrical power lines and equipment.
 - .2 Separation between open communication cables or cables in non-metallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - .1 Electrical Equipment Rating Less Than 2 kVA: a minimum of 5 inches (127mm).
 - .2 Electrical Equipment Rating Between 2 and kVA: a minimum of 12 inches (300mm)
 - .3 Electrical Equipment Rating More Than 5kVA: a minimum of 24 inches (610mm).
 - .3 Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - .1 Electrical Equipment Rating Less Than 2kVA: a minimum of 2.5 inches (64mm).
 - .2 Electrical Equipment Rating Between 2 and 5kVA: a minimum of 6 inches (150mm).
 - .3 Electrical Equipment Rating More Than 5kVA: a minimum of 12 inches (300mm).
 - .4 Separation between communication cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosure shall be as follows:
 - .1 Electrical Equipment Rating Less than 2kVA: No Requirement.
 - .2 Electrical Equipment Rating Between 2 and 5kVA: a minimum of 3 inches (76mm).
 - .3 Electrical Equipment Rating More Than 5kVA: a minimum of 6 inches (150mm).

3.2 CABLE TERMINATION

- .1 shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-B standard document, manufacturer's recommendation and best industry practice.

- .2 Pair untwist at the termination shall not exceed 12mm (one-half inch). Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.
- .3 The cable jacket shall be maintained to within 25mm (one inch) of the termination point.
- .4 Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.
- .5 Cable termination shall start at the upper left point of the terminal block mount and proceed in a left to right manner downward for each succeeding cable row.
- .6 All cross-connection data cables to the equipment rack shall be run down the backside of the cable raceway between the racks and up before terminating on the back side of the patch panels.

3.3 FIRESTOP SYSTEM

- .1 All firestop systems shall be installed in accordance with the manufacturer's recommendations and shall be completely installed and available for inspection by the local inspection authorities prior to cable system acceptance.
- .2 Comply with TIA/EIA-569-9, Annex A, "Fire Stopping".

3.4 GROUNDING SYSTEM

- .1 The TBB shall be designed and/or approved by a qualified P.ENG., licensed in the Province that the work is to be performed. The TBB shall adhere to the recommendations of the ANSI/TIA/EIA-607 standard, and shall be installed in accordance with best industry practice.
- .2 A licensed electrical contractor shall performed installation and termination of the main bonding conductor to the building service entrance ground.

3.5 LABELING

- .1 All labels shall be mechanically generated. All network labeling applications shall be performed as described in TIA/EIA-606-A Administration Standard for Commercial Telecommunications Infrastructure.
- .2 NOTE: The contractor shall confirm labeling criteria with the PCA Departmental Representative and Owner prior to labeling cables.

3.6 TESTING

- .1 General: All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA/EIA-568-B. All pairs of each cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed.
- .2 Consult with PCA Departmental Representative if cable test over length for replacement or

.3 Copper Channel Testing:

- .1 All twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance as indicated below. Additional testing is required to verify Category performance. Horizontal cabling shall be tested using a Level 3 test unit for Category 6 performance compliance.
- .2 Continuity: Each pair of each installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. The test shall be recorded as pass/fail as indicated by the test unit and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.
- .3 Length: Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the ANSI/TIA/EIA-568-B Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cables, the shortest pair length shall be recorded as the length for the cable.
- .4 Category 6 performance: For performance testing should be done according to the published ANSI/TIA/EIA-568-B.2-1

.4 Optical Fiber Cable Tests

- .1 Test instruments shall meet or exceed applicable requirements in TIA/ EIA-568C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- .2 Link End to End Attenuation Tests:
 - .1 Horizontal and multimode backbone link measurements. Test at 850 or 1300 nm in one direction according to TIA / EIA-526-14-A, Method B, One Reference Jumper.
 - .2 Attenuation Test results for backbone links shall be less than 2.0db. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568B.1.

.5 Record results on cabling contractor supplied forms as accepted by the Owners representative.

.6 The owner and/or Owners representative reserves the right to request additional testing when failures are encountered.

.7 Submit test results to the Owner for review and place in O&M Manual

.8 The Owner reserves the right to perform random tests prior to project closeout.

3.7 PRODUCTS PROVIDED BY THE OWNER

- .1 Owner will provide and install all active equipment components, including UPS.
- .2 Coordinate active equipment locations with the Owner prior to terminating cables.

3.8 SYSTEM DOCUMENTATION

- .1 Completion of the installation, the telecommunication contractor shall provide one (1) full documentation set and one (1) electronic set to the PCA Departmental Representative for approval.
Documentation shall include the items detailed in the sub-section below.
- .2 Documentation shall be submitted within then (10) working days of the completion of each testing phase (e.g. subsystem, cable type, area, floor, etc.). This is inclusive of all test results and draft as-built drawings. Draft drawings may include annotations done by hand. Machine generated (final) copies of all drawings shall be submitted within 30 working days of the completion of each testing phase.
- .3 The PCA Departmental Representative May request that a 10% random field re-test be conducted on the cable system, at no additional cost, to verify document findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the telecommunications contractor, additional testing can be requested to the extent determined necessary by the PCA Departmental Representative, including a 100% re-test. This re-test shall be at no additional cost to the Owner.
- .4 **Test Results:** Documentation shall be provided in electronic format within three weeks after the completion of the project. The media shall be clearly marked on the outside front cover with the words "Project Test Documentation", the project name and the date of completion (month and year). The results shall include a record of test frequencies, cable type, conductor pair and cable (or outlet) I.D., measurement direction, reference setup, and crew member name(s). The test equipment name, manufacturer, model number, serial number, software version and last calibration date will also be provided at the end of the document. Unless the manufacturer specifies a more frequent calibration cycle, an annual calibration cycle is anticipated on all test equipment used for this installation. The test document shall detail the test method used and the specific settings of the equipment during the test as well as the software version being used in the field test equipment.
- .5 The **As-Built** drawings are to include cable routes and outlet locations. Their sequential number as defined elsewhere in this document shall identify outlet locations. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided. The Owner will provide floor plans in paper and electronic (DWG, AutoCAD rel. 14) formats on which as-built construction information can be added. These documents will be modified accordingly by the telecommunications contractor to denote as-built information as defined above and returned to the Owner
- .6 The Contractors shall annotate the base drawings and return a hard copy (same plot size as originals) and electronic form (AutoCAD).

END OF SECTION

1. General

1.1 DESCRIPTION

- .1 Provide encased pvc conduit or fibre duct from property line to main telephone terminal board. Refer to drawings for location of telephone board, exact conduit size and Number of conduits required.
- .2 Contractor to coordinate entire telephone & cable vision installation with Utility company. Include cost in total tender price. Also coordinate with the owner to insure all costs are accounted for and the installation meets the Owner's needs.
- .3 Provide a #6 ground cable to main telephone board. Allow for minimum 200 pair cable installation from the Utility Company.
- .4 Telephone and cablevision outlet to be standard spec grade device box 50mm x 75mm c/w white cover plates. Terminate telephone wiring at appropriate outlets.
- .5 Supply and install "bix" blocks are required. Terminate all telephone cable on telephone board.

2. Products

2.1 CABLING

- .1 Voice cabling contractor to refer to Section 27 10 00 for all cabling requirements.

3. Products

3.1 DEVICES

- .1 Size all telephone outlet boxes and conduit as shown on drawings.
- .2 Provide pull boxes in all runs in excess of 30 meters or where more than two 90° bends occur.
- .3 Conduit shall conform to the requirements of Section and shall be a minimum 21mm.
- .4 Mount bottom of outlets at 1,500mm a box finished floor or as noted on drawings. Typically, in bottom of fourth block course in concrete block walls.
- .5 Junction boxes for outlets to be flush mounted in wall. Appropriate extension rings are to be provided where outlets are to be installed in millwork, backboards, chalkboards, etc.

END OF SECTION

I. GENERAL

1.1 SUMMARY

- .1 The work covered under this Section consists of furnishing all labor, material and services to install a complete audiovisual system as indicated on the Contract Documents.
- .2 The scope of work covered under this Section includes but is not limited to:
 1. Equipment and installation labor as noted on the Contract Documents for a fully functional system. Miscellaneous components, hardware, interconnections and terminations required for proper operation of all systems.
 2. All components or systems indicated on the Contract Documents.
 3. The Installing Contractor shall be responsible for the following:
 - a. Verification of accuracy and completeness of equipment lists, dimensions, mounting details and equipment compatibility
 - b. Accurate documentation of the system operation and installation.
 - c. One year warranty of the equipment and installation.
 - d. Test equipment, tools, ladders, lifts and scaffolding required for installation.
 - e. Daily and final cleanup of debris caused by installation.
 - f. Quality Control / Commissioning of system
 - g. End user training and training manuals

1.2 SYSTEM(S) DESCRIPTION

1.3 INSTALLING CONTRACTOR

- .1 Certification:
 1. The Installing Contractor shall have a current INFOCOMM's "Audio Visual Solutions Provider" (AVSP) certification. The certifications shall match the level and complexity of the scope of work as follows:
 - a. System Category One (\$10,000 to \$49,000)
 - AVSP Sapphire status will be preferred as a minimum status for this work.
 - b. All Other System Categories
 - AVSP Emerald status will be a minimum status for this work.

1.4 INSTALLING CONTRACTOR PERSONNEL QUALIFICATIONS

- .1 Summary: The Installing Contractor shall assign at least one full-time employee to the work whose qualifications meet the following minimum requirements.
 - .1 On-Site AV Supervision
 - a. Certifications:

- Shall have a current INFOCOMM Certified Technology Specialist certification with an installation endorsement (CTS-I) in good standing
- b. Qualifications:
 - Shall be capable of supervising a turn-key audiovisual system installation including, but not limited to, all cabling, speakers, projection equipment, mounting hardware and electrical components including the necessary equipment, interconnections, transducers, labor, and services required to meet the functional requirement outlined in the Contract Documents.
 - Shall provide all quality control (QC) and safety inspections as needed throughout installation.
 - Shall conduct all AV system commissioning tests, and proof-of-performance testing/demonstration in accordance with the Contract Documents.
- 2. Other Installation Personnel:
 - a. Certification:
 - Must have a CTS certification
 - No more than four (4) CTS certified installers for every CTS-I certified installer on-site.
 - b. Qualifications:
 - Shall be capable of working within industry standards with minimal supervision. The work shall include, but is not limited to, cabling, loudspeakers, projection equipment, mounting hardware and electrical components including the necessary equipment, interconnections, and transducers and the downloading, or installation, of pre-developed control programs in the field.
- 3. On-Site Support Personnel:
 - b. Certification:
 - CTS Preferred
 - c. Qualifications:
 - Has a good general knowledge of AV installation procedures and standards, and must be trained in construction site safety. Performs support work under direct supervision of CTS and CTS-I installers.
- 4. AV Control Programmer: AV control and DSP programming for system equipment includes recommendations for control system features and functionality; input to AV system design; control system logic diagram, control system performance specification, block diagrams, control system program and user interface, system debug, program and source code and other system documentation as required.
 - a. Certification

- Must have a CTS certification, CTS-I or CTS-D certification preferred
- Individuals performing the AV control programming shall have manufacturer's control system programming training and certification for the specified AV control system
- Individuals performing AV-DSP programming and setup shall have manufacturer's system programming training and certification from the manufacturer for specified equipment.

5. Commissioning Personnel

- a. Shall have a current AQAV Certified Quality Technician (CQT) certification in good standing.

- Qualifications: Shall be capable of performing commissioning tests during staging and final commissioning of the system according to the Av 9000: Quality management System For the Audio Visual Technology Industry.

6. Sub-contracting of AV work

- a. Conditions: Sub-Contractors must conform to the same certification standards listed above, and have prior approval.

1.5 INSTALLING CONTRACTOR All equipment and installations under this contract shall conform to the following:

- .1 ANSI/NFPA 70 National Electrical Code.
- .2 ANSI/IEEE C2 National Electrical Safety Code TIA/EIA Standards 568 A (including TSB 67), and 607.
- .3 IEE/ANSI 142 1982 Recommended Practice for Grounding of Industrial and Commercial Power Systems.
- .4 *ANSI/TIA-569B Commercial Building Standard for Telecommunications Pathways and Spaces*
- .5 NFPA 72-2010; *National Fire Alarm and Signaling Code [intelligibility requirements]*

1.6 INSTALLING CONTRACTOR REFERENCES/GUIDES

- .1 Infocomm International, (2009) AV Installation Handbook (2nd ed.)
 - .1 Giddings, P. (1990). Audio Systems Design and Installation. Boston: Focal Press.
 - .2 AQAV, (2015) AV 9000:2015 Quality management System for the Audio Visual Technology Industry.
 - .3 ANSI/INFOCOMM 1M-2009, *Audio Coverage Uniformity in Enclosed Listening Areas*
 - .4 ANSI/INFOCOMM, *Networked AV Systems*

1.7 WORK PRODUCT OWNERSHIP

- .1 Throughout the course of the project, all supporting documentation, work-in-

progress, programed source code and software, written and electronic files, including all documentation and software necessary to edit and adapt the system, shall remain the property of Parks Canada and shall be provided to Parks Canada upon project completion and/or at any time during the course of a project upon request in an unsecured, unencrypted and easily modifiable format as prescribed by Parks Canada.

1. All deliverables to be supplied to Parks Canada on compact disc media, and/or printed materials when requested
- .1 Software – Control System, DSP, and All Other Applicable Equipment
 1. The software developer shall retain intellectual property rights to the operation software. The Owner shall be granted a license in perpetuity for use. The following requirements shall apply.
 - a. All source code becomes the exclusive property of Parks Canada.
 - b. All source code changes must be fully documented.
 - c. All custom programs for remote control system touch panels, and other programmed devices, shall become the property of Parks Canada and shall be submitted with the final systems documentation, and/or as requested in the DVD/CD-ROM and USB solid state media.
 - d. Subsequent to system certification, source code changes and/or additional programming, whether requested by Parks Canada or performed by the Installing Contractor, will be warranted by the Installing Contractor for a period of one (1) year, with the Installing Contractor responsible for the diagnosis and repair.
 - e. The vendor shall ensure that the current program is saved to CD-ROM and/or USB-solid state media, and backed up on electronic hard-disc/server.
 - f. No program resident in a control system shall be overwritten until a back-up of the resident program is made.
 - g. All documentation, not residing in the code, must be provided on CD-ROM and/or USB-solid state media in Adobe PDF and Microsoft Office format.
 - .2 The Installing Contractor shall also offer an annual "Software Maintenance" contract.
 - A. This shall cover all software provided as part of this system and/or written for this system, and shall include both routine upgrades to applications and operating systems, as well as any modifications to software that may be required by Any Company.
 - B. The Software Maintenance contract shall commence immediately after expiration of the warranty period, and continue for three (3) years.
 - .3 Written Release:
 - A. A written release will be given by the Installing Contractor for all control programming done by the Installing Contractor's personnel or sub-contractors. The release shall acknowledge Parks Canada's ownership and right to modify programming directly, or to have the programming modified by others on Parks Canada's behalf.

- B. A CD shall be supplied with the written release that includes the program and source code for the system in an unencrypted format.

1.8 CONTRACTOR SUBMITTALS

- .1 Prior to fabrication, the Contractor shall submit to Parks Canada, for approval, any custom designs pertaining to the systems. Contractor is to provide six (6) sets of all documentation. Drawing submittals shall be submitted electronically on CD-ROM, DVD- ROM or USB-solid state media. These designs include, but are not limited to, the following:
- .1 Complete system construction and point to point wiring schematic drawings, including all component values, and showing complete letter and number identification of all wire and cable as well as jacks, terminals and connectors. All connections types are to be shown.
 - .2 Provide bound technical specification details (cut sheets) on all equipment required to complete this project.
 - .3 All control system front panel layouts, where applicable.
 - .4 All panels, plates, and designation strips, including details relating Terminology, engraving finish and color.
 - .5 All custom designed consoles, tables, carts, support bases, and shelves. Schematic drawings of all custom components, assemblies, and circuitry, including wall and/or floor plates.
 - .6 All unusual equipment modifications,
 - .7 Run sheets or field wiring details
 - .8 Patch panel assignment layout drawings
 - .9 Front mechanical drawings of each equipment rack.
 - .10 Complete spreadsheet lists of IP network devices, protocols used, and IP and MAC Address lists and required ranges for coordination with the Owner's IT department.
 - .11 Lists shall include information regarding location on the Owner's network or dedicated audiovisual physical subnet, VPN requirements, and other pertinent information for integration of IP networked audiovisual equipment into the Owner's Enterprise network.
 - .12 All items of equipment, whether a stock manufactured item or custom-built item, shall be supported by complete and detailed schematic drawings and replacement parts lists. No "black boxes" or unidentified components shall be acceptable under this specification
 - .13 Verification of the focal lengths of projection lenses to achieve the specified image sizes.
 - .14 Verification of audio uniformity coverage and speaker coverage layout.
 - .15 A site RF wireless frequency spectrum analysis of RF spectrum to be used by any specified equipment. A spectrum analyzer shall be used with software and recording of results on a typical weekday during normal anticipated hours of use. Results shall be submitted with a frequency analysis and assignment plan.

- .16 Proposed commissioning and testing procedures and processing, including testing documentation and results to be provided to the Owner prior to Owner's Punch list checkout.
- .17 Proposed training programs, including schedule, component-level and systems-level training sessions, and Staff who will be conducting the training, along with qualifications and resumes.
- .18 If the Contractor will be providing manufacturer training, then the submittal shall include component or systems training by each manufacturer, along with the manufacturer's training staff and their qualifications.
- .19 This information shall be provided prior to commissioning, for the Park Canada and Consultant's review and approval.
 - a. End-user guides, subject to Owner review and approval, which are "function-oriented" in showing a step-by-step operation process for the main startup and functions of each room system. The end-user guides must be comprehensive in scope and cover each user application of the room capabilities. User-guides of the "traditional" laminated sheet of user-interface photos with tagged annotations will NOT be accepted.
- .20 Close Out Submittals
 - a. At the completion of the installation, the Contractor shall electronically provide six (6) copies each of the following:
 - b. Test results, in "spreadsheet" format, of electrical audio and/or video performance testing for all systems end-to-end in every room and/or between rooms as applicable.
 - c. Total equipment database.
 - d. NOTE: It is the sole responsibility of the Contractor to fully test the audiovisual systems prior to owner check-out and verification. Until these test results are provided, no audiovisual systems check-out or verifications (functional or otherwise) will be performed by the Owner. If any anomalies in system performance are detected, the Contractor shall correct these before performing any other tests.
 - e. Equipment manufacturer's operation manuals for each piece of equipment.
 - f. "As-built" drawings. A final, approved copy shall be placed in a metal pocket mounted on the inside of the rear door of the rack.
 - g. System functional block drawing identical to the specification drawing with the addition of all input and output circuit cable and terminal block numbers as well as all jack field circuit I.D. designations. A copy of this drawing shall be framed in protective plastic and mounted near the equipment racks.
 - h. A System Operation and Maintenance Manual. This manual shall be produced by the Contractor especially for the systems detailed herein. The "Operation" section shall describe all typical procedures necessary to activate each system to provide for the functional

- i. requirements as listed under the Detailed Specifications. Manuals will use graphical representation of touch panel screens, as to easily be identified by user. Owner's Manuals and/or Operations manuals supplied by manufacturers for a given piece of equipment, though required, are not acceptable substitutes for these materials.
- j. The reader of this manual shall be assumed to be technically competent, but unfamiliar with this particular facility. Additionally, the Contractor shall provide a single page of basic operating instructions for each room, and other audio-visually equipped spaces.

1.9 WARRANTY

- .1 The warranty period shall start after final checkout and signed off by the owner or Parks Canada representative. The warranty shall cover 365 calendar days starting on the day of acceptance.
- .2 To maintain certain manufacturer's warranties, equipment must be installed, aligned and serviced by those installers authorized by that manufacturer to perform those duties. If the Installing Contractor is not authorized, by the manufacturer, it is the Installing Contractor's sole responsibility to make the appropriate arrangements and bear all cost and consequences
- .3 In cases where the manufacturer's warranty period is greater than specified in the Contract Documents, the Installing Contractor shall provide that warranty for the full extent of the manufacturer's warranty period.
 - .1 The Installing Contractor shall exclude any labor costs incurred by removing and re-installing the defective items after the system's one-year warranty.
- .4 In cases where the manufacturer's warranty period is less than 12 months, the Installing Contractor shall warrant the system(s) in accordance with the Contract Documents.

- .5 All manufacturers' equipment warranties shall be activated in the Owner's name and shall commence on the date of Substantial Completion.
- .6 In the case of Installing Contractor-modified equipment, the manufacturer's warranty is normally voided. In such cases, the Installing Contractor shall provide the Owner with a warranty equivalent to that of the original manufacturer.
- .7 In the event of malfunction or failure of any audiovisual equipment provided by the Installing Contractor, the Installing Contractor shall be responsible for replacement of faulty equipment, or providing "loaner" equipment at no cost to the Owner for the duration of the repairs. In the event that "loaner" equipment is provided, said equipment shall meet or exceed the original equipment specifications until the original equipment is replaced.

- .8 In cases where the Installing Contractor is providing and installing audiovisual equipment and/or hardware to be integrated with equipment furnished by others, it shall be the responsibility of the Installing Contractor to warrant their equipment as described in the Contract Documents unless said equipment shows misuse and or abuse by others during re-installation or connection of equipment by others.
- .9 Telephone Support
 - 1. The Installing Contractor shall respond via telephone within two (2) hours to any request for service.
 - 2. This first contact should outline the nature of the problem or functional anomaly.
 - 3. The Installing Contractor shall make available personnel knowledgeable with the installed system who can address specific system issues described by the system operators.
 - 4. Telephone support shall be available between normal business hours, Monday through Friday.
- .10 On-Site Support
 - 1. The warranty shall be an "on-site" warranty, with a twenty-four (24) hour response time.

2 PRODUCTS

2.1 GENERAL

2.2 SYSTEMS

- .1 Description, See drawings for speaker specifications.
- .2 Operation Sequences
- .3 Performance
- .4 Manufacturers
 - a.Substitution Limitations
 - b.Product Options

2.3 CONTROL SYSTEM PROGRAMMING

- .1 Required Deliverables
 - a.In Microsoft Excel, a page by page, button by button list will be provided for system commissioning. This should include the function of each button, page flips, popup pages etc.
 - b.Program Requirements

2.4 DSP (DIGITAL SIGNAL PROCESSING) PROGRAMMING

- .1 Required Deliverables
- .2 Program Requirements

2.5 MATERIALS

.1 Cable

a. Audio

a. Fixed Installation

(1) Speaker Cable

a. 18/2 Twisted Pair Cable with Overall Jacket

1. Non-Plenum

a. Manufacturer: Extron, Model: SPK18, 22-150-03

b. Manufacturer: Gepco 1800

c. Or pre-approved equal

2. Plenum

a. Manufacturer: Extron, Model: SPK18P, 22-153-03

b. Manufacturer: Gepco 1800HS

c. Or pre-approved equal

b. 16/2 Twisted Pair Cable with Overall Jacket

1. Non-Plenum

a. Manufacturer: Extron, Model: SPK16, 22-151-03

b. Manufacturer: Gepco 1600

c. Manufacturer: Liberty 16-2C-COM

d. Or pre-approved equal

2. Plenum

a. Manufacturer: Extron, Model: SPK16P, 22-154-03

b. Manufacturer: Gepco 1600HS

c. Manufacturer: Liberty 16-2C-P

d. Or pre-approved equal

c. 14/2 Twisted Pair Cable with Overall Jacket

1. Non-Plenum

a. Manufacturer: Extron, Model: SPK14, 22-152-03

b. Manufacturer: Gepco 1400

c. Manufacturer: Liberty 14-2C-GRY

d. Or pre-approved equal

2. Plenum

a. Manufacturer: Extron, Model: SPK14P, 22-155-03

b. Manufacturer: Gepco 1400HS

c. Manufacturer: Liberty 14-2C-P-BLK

d. Or pre-approved equal

- d. 12/2 Twisted Pair Cable with Overall Jacket
 - 1. Non-Plenum
 - a. Manufacturer: Gepco 1200
 - b. Manufacturer: Liberty 12-2C-GRY
 - c. Or pre-approved equal
 - 2. Plenum
 - a. Manufacturer: Gepco 1200HS
 - b. Manufacturer: Liberty 12-2C-P-BLK
 - c. Or pre-approved equal
- (2) Microphone
 - a. 22 AWG Stranded Oxygen-free BC, Foam Polypropylene Insulation, & 95% TC Braid.
 - 1. Manufacturer: Gepco XB201M
 - 2. Manufacturer: Belden 8451
 - 3. Or pre-approved equal
- (3) Line Level Balanced
 - a. 22 Gage STP, Low Attenuation, Low Crosstalk Audio Cable.
 - 1. Manufacturer: Gepco 61801EZ
 - 2. Manufacturer: Extron STP22, 22-156-03
 - 3. Or pre-approved equal
- (4) Line Level Unbalanced
 - a. 22 Gage STP, Low Attenuation, Low Crosstalk Audio Cable.
 - 1. Manufacturer: Gepco 61801EZ
 - 2. Manufacturer: Extron STP22, 22-156-03
 - 3. Or pre-approved equal
 - b. Portable/Lectern/Flexible
 - (1) Microphone
 - a. 22 AWG Stranded Oxygen-free BC, Foam Polypropylene Insulation, & 95% TC Braid.
 - 1. Manufacturer: Gepco XB201M
 - 2. Manufacturer: Belden 8451
 - 3. Or pre-approved equal
 - (2) Line Level Balanced
 - a. 22 Gage STP, Low Attenuation, Low Crosstalk Audio Cable.
 - 1. Manufacturer: Gepco 61801EZ
 - 2. Manufacturer: Extron STP22, 22-156-03
 - 3. Or pre-approved equal
 - (3) Line Level Unbalanced

- a. 22 Gage STP, Low Attenuation, Low Crosstalk Audio Cable.
 - 1. Manufacturer: Gepco 61801EZ
 - 2. Manufacturer: Extron STP22, 22-156-03
 - 3. Or pre-approved equal
- .2 Connectors
 - a. Audio
 - a. Balanced
 - (1) ¼" TRS male cable mount connector, solder on, Nickel/gold plated
 - a. Manufacturer: Neutrik NJ3FC6 female
 - b. Manufacturer: Neutrik NP3X male
 - c. Manufacturer: Switchcraft 297 male
 - d. Manufacturer: Switchcraft 131 female
 - e. Or pre-approved equal
 - (2) ¼" TRS panel mount jack, solder on,
 - a. Manufacturer: Neutrik "locking jacks series"
 - b. Manufacturer: Switchcraft "enclosed jack"
 - c. Or pre-approved equal
 - (3) XLR 3-pin cable mount connector, solder on, Nickel/gold plated
 - a. Manufacturer: Neutrik NC3MXX male
 - b. Manufacturer: Neutrik NC3FXX female
 - c. Manufacturer: Switchcraft A3F female
 - d. Manufacturer: Switchcraft A3M male
 - e. Or pre-approved equal
 - (4) XLR 5-pin cable mount connector, solder on, Nickel/gold plated
 - a. Manufacturer: Neutrik N5CFX female
 - b. Manufacturer: Neutrik N5CMX male
 - c. Manufacturer: Switchcraft A5F female
 - d. Manufacturer: Switchcraft A5M male
 - e. Or pre-approved equal
 - (5) XLR 3-pin panel mount connector, solder on,
 - a. Manufacturer: Neutrik NC3FD-LX female
 - b. Manufacturer: Neutrik NC3MD-LX male
 - c. Manufacturer: Switchcraft D3F female
 - d. Manufacturer: Switchcraft D3M male
 - e. Or pre-approved equal
 - (6) XLR 5-pin panel mount connector, solder on,

- a. Manufacturer: Neutrik NC5FD-LX female
 - b. Manufacturer: Neutrik NC5MD-LX male
 - c. Manufacturer: Switchcraft D5F female
 - d. Manufacturer: Switchcraft D3M male
 - e. Or pre-approved equal
- (7) XLR-1/4" Combination panel mount connector, solder on,
- a. Manufacturer: Neutrik "Combo" series male
 - b. Manufacturer: Neutrik "Combo" series female
 - c. Or pre-approved equal
- b. Speaker Level
- (1) Lockable loudspeaker cable mount connector, solder on
- a. Manufacturer: Neutrik "speakON series" female
 - b. Manufacturer: Neutrik "speakON series" male
 - c. Manufacturer: Switchcraft "HPC series" female
 - d. Manufacturer: Switchcraft "HPC series" male
 - e. Or pre-approved equal
- (2) Lockable loudspeaker panel mount connector, solder on
- a. Manufacturer: Neutrik "speakON series" female
 - b. Manufacturer: Neutrik "speakON series" male
 - c. Manufacturer: Switchcraft "HPC series" female
 - d. Manufacturer: Switchcraft "HPC series" male
 - e. Or pre-approved equal
- c. Unbalanced
- (1) 1/4" mono cable mount connector, solder on, Nickel/gold plated
- a. Manufacturer: Neutrik NYS224 male
 - b. Manufacturer: Neutrik NP2X female
 - c. Manufacturer: Switchcraft 280 male
 - d. Manufacturer: Switchcraft 121 female
 - e. Or pre-approved equal
- (2) 3.5mm mini stereo cable mount connector, solder on, Nickel/gold plated
- a. Manufacturer: Extron 3.5 mm Mini Stereo-HQ male, 100-331-01
 - b. Manufacturer: Switchcraft 35HDNN male
 - c. Or pre-approved equal
- (3) RCA cable mount connector, solder on
- a. Manufacturer: Extron RCA-HQ male, 100-334-01
 - b. Manufacturer: Neutrik NYS352G

- c. Or pre-approved equal
 - (4) 1/4" mono panel mount jack, solder on,
 - a. Manufacturer: Neutrik "locking jacks series"
 - b. Manufacturer: Switchcraft "enclosed jack"
 - c. Or pre-approved equal
 - d. Category Cable
 - a. Cat 6 crimp plug
 - (1) Liberty 11108080034
 - (2) Comprehensive RJ45P-6
 - (3) Or pre-approved equal
 - b. Cat6a Crimp Plug
 - (1) Manufacturer: Liberty RJ45-STP-L6
 - (2) Or pre-approved equal
- .3 Pre-manufactured Cables and Adapters
 - a. All pre-manufactured cables should have the following minimum specifications:
 - a. **High performance cables designed for transmission of video.**
 - b. **Terminated with high quality 75 ohm BNC connectors.**
 - c. **VGA shell grounded for ESD electrostatic discharge protection.**
 - d. **Injection mold with overall foil shield for improved EMI electromagnetic interference isolation.**
 - e. **Acceptable manufacturers**
 - (1) **Manufacturer: Extron**
 - (2) **Manufacturer: Liberty**
 - (3) **Manufacturer: Comprehensive**
 - (4) Or pre-approved equal
- .4 Hardware
 - a. Wall/floor plates and rack panels
 - a. NEMA gang plates shall be standard or jumbo sized as required at each location.
 - b. Plates shall be sized to fit rough opening or fit box opening.
 - c. Text and graphics shall be engraved.
 - d. Connectors shall be fitted to plates using nuts, screws, or by the method designated by connector. No rivets.

- e. Acceptable manufacturers
 - (1) Manufacturer: Panel Crafters
 - (2) Manufacturer: Whirlwind
 - (3) Or pre-approved equal

3 - EXECUTION

3.1 PREPARATION

- .1 Before starting installation, verify proper installation of the following work by others -
 - 1. Document and submit a single report for each space with AV to the Parks Canada Departmental Rep before any work is started on-site
 - 2. Carry out this requirement for each phase of work on-site (field wiring, and system/equipment installation) for each space with AV.
- .2 Frequency Coordination - Prior to ordering equipment, the Installing Contractor shall coordinate the frequencies of all wireless devices to prevent unwanted interaction between devices and rooms.
 - 1. This includes, but is not limited to, wireless microphones, assisted listening system devices, wireless control panels, etc.
 - 2. Frequency coordination shall take place with the use of a spectrum analyzer and frequency allocation/analysis software.
 - 3. Documentation of this frequency coordination shall be provided to the Owner for review.

3.2 QUALITY CONTROL/COMMISSIONING

- 1. See related Performance Standards and Testing Procedures paragraphs in Part 3 of this technical section.
- 2. The main AV milestones that testing will be required:
 - .1 Prototype verifications (off-site and on-site)
 - .2 Staging Testing
 - .3 Final System Commissioning
 - .4 Final Checkout

3.3 INSTALLATION PRACTICES

- .1 General
 - 1. All installation practices shall be in accordance with, but not limited to, these specifications and drawings. Installation shall be performed in accordance with the applicable standards, requirements, and recommendations described in the Contract Documents, referenced material, and the *U of I Facilities Standards*.
 - 2. Installation shall include the delivery to the installation site, unloading, setting in place, fastening to walls, floors, ceilings, counters, or other structures where required, interconnecting wiring of the system components, equipment alignment and adjustment, and all other work

whether or not expressly required herein which is necessary to result in complete and fully operational systems.

.2 Physical Installation

1. In the installation of equipment and cable, consideration shall be given not only to operational efficiency, but also to overall aesthetic factors
2. All accessories, including rack mounting hardware, power supplies, etc., shall be obtained from the original equipment manufacturer. Unless otherwise noted or specified, third party accessories shall not be used

3. Trim and Escutcheon Components

- a. To insure a proper finished appearance, the AV Installing Contractor shall furnish and install trim/escutcheon components at all conditions where A/V components pass through the finished ceilings. This would include but not be limited to video projector supports, television monitor/receiver supports and any other component which is not specifically supplied with integral flanges/trim components; i.e. speaker mounts, assistance listening devices, etc
- b. The visible component of any trim should be minimal in size, preferably no wider than 1/2". All trim components at the ceiling plane shall be finished to match the approved ACT ceiling grid system components.
- c. All trim components shall be submitted for review and approval prior to fabrication

4. Mounting

- a. All equipment shall be firmly secured in place unless requirements of portability dictate otherwise.
- b. Fastenings and supports shall be adequate to support their loads with a safety factor of at least five (5). All boxes, equipment, etc., shall be secured plumb and square.
- c. All displays and video projectors must have security cables attached to the building structure or other approved methods to assist in the prevention of loss.
- d. Other equipment, not designated as 'Portable' shall be provided with security fasteners, secured to furniture, or otherwise secured, using approved methods or materials as described in the Contract Documents

.3 Cable Installation

1. Cable General Installation

- a. All wire bundles are to be neat and combed free of cable crossovers.
- b. All cables shall be grouped according to the signals being carried. In order to reduce signal contamination, separate groups shall be formed for the following cable families:
 - Power cables
 - Control cables
 - Audio cables carrying signals less than – 20 dBm
 - Audio cables carrying signals between – 20 dBm and +20 dBm

- Audio cables carrying signals above +20 dBm
 - c. All cables shall be cut to the length dictated by the run. No splices shall be permitted in any pull boxes.
 - d. Cables running in plenum areas without conduit shall be plenum rated cable, and match the specified cable above.
 - (a) It is the responsibility of the Installing Contractor to inspect the Contract Documents, and verify in what spaces plenum cable shall be used.
 - (b) No claims for additional monies, based on the use of plenum cable, will be allowed
2. Cable – Rack/Termination Points
- a. Cable separation/routing:
 - (a) All power cables, control cables, and high level cables shall be run on the left side of an equipment rack as viewed from the rear.
 - (b) All other cables shall be run on the right side of an equipment rack, as viewed from the rear.
 - b. All cable entry shall be through the tops of racks or through entrance holes in the base of the rack. No cable shall enter racks through front, rear or side panel openings
 - c. Cables shall not protrude from the back of racks.
 - d. Cables ties shall be placed at appropriate intervals of no greater than six inches for vertical bundles, two inches for horizontal bundles.
 - e. All vertical cable bundles shall be attached to the rack frame.
 - f. For equipment mounted in drawers or on slides, the interconnecting cables shall be provided with a service loop of appropriate length
 - g. All cable entry shall be through the tops of racks or through entrance holes in the base of the rack. No cable shall enter racks through front, rear or side panel openings
 - h. All system wire, after being cut and stripped, shall have the wire strands twisted back to their original lay and be terminated by approved soldered or mechanical means.
 - i. Except where noted otherwise in the specifications, NO BARE WIRE TERMINATIONS WILL BE ACCEPTED.
 - j. Heat-shrink tubing shall be used to insulate the ground or drain wire.
 - k. Unused wires at the end of a cable shall remain unstripped and shall be laid back and held in place with wire ties.
 - l. All solder connections shall be made with rosin-core solder using temperature-controlled solder stations.
 - (a) Care shall be taken to avoid cold or cracked solder joints. Any connections that do not appear to be clean and shiny, or which show signs of cracking, shall be resoldered by the Installing Contractor before acceptance of the system.
 - m. Mechanical connections using insulated, crimp-type connectors shall be bonded to the connector by soldering the wire to the metal part of the connector.

- n. Connections made with screw actuated pressure type terminal strips shall be made by stripping approximately 1/4 inch of insulation from the stranded conductor. Then the un-tinned wire shall be inserted into the terminal and the screw tightened using a secure fitting precision screwdriver
 - o. Terminal blocks, boards, strips, or connectors shall be furnished for all cables which interface with racks, cabinets, consoles, or equipment modules.
 - p. All cables shall have proper connector housing.
- 3. Cable – Labeling
 - a. All cables, regardless of length, shall be marked with a permanent, self-laminating wrap-around number or letter cable marker at both ends, similar to the Brady and Panduit products for laser/ink-jet printers, and handheld thermal printers.
 - (a) A000x for audio
 - (b) V000x for analog video
 - (c) D000x for digital video
 - (d) N000x for network
 - (e) C000x for control
 - (f) P000x for power
 - (g) Or other pre-approved schemes
 - b. Labels must be computer-generated for legibility.
 - c. Wire labels done by hand in the field must be replaced with computer generated labels.
 - d. There shall be no unmarked cables at any place in the system.
 - e. Marking codes used on cables shall correspond to codes shown on drawings and or run sheets.
 - f. All wire markers shall face a common direction.
- 4. Connector Plate Receptacles
 - a. Audio (microphone or line level) – XLR, locking type.
 - b. Audio (line level—Mono or Stereo) – 1/4" jack, locking type Jack shall be insulated from panel type
 - c. Audio (loudspeaker level) – lockable loudspeaker panel mount connector Type.
 - d. Audio (multipin analog mic/line level) – 61 pin circular bayonet type – Jack shall be insulated from panel type.
 - e. Intercom Panels – XLR type.
 - f. Video – BNC type.
 - g. VGA – DB-15HD jack, isolated from panel type, with hex nuts.
 - h. RF (CCTV/CATV) – "F" type. Receptacles shall be insulated from panel type.

- i. RF (Wireless Antennae) – BNC type, 75 or 50 Ohm, as required. Receptacles shall be insulated from panel type.
 - j. Digital Audio Snake/UTP transmission – RJ-45 type.
 - k. Note: All connectors on wall plates, or in other exposed locations, are to be recessed.
- .5 Grounding – In order to minimize problems resulting from improper grounding, and to achieve maximum signal-to-noise ratios, the following grounding procedures shall be adhered to:
- 1. System Grounds:
 - a. A single primary “system ground” shall be established for the systems in each particular area. All grounding conductors in that area shall connect to this primary system ground.
 - b. The system ground shall be provided in the audio equipment rack for the area, and shall consist of a copper bar of sufficient size to accommodate all secondary ground conductors.
 - c. A copper conductor having a maximum of 0.1 Ohms total resistance shall connect the primary system ground bar to the nearest approved electrical ground.
 - d. Secondary system grounding conductors shall be provided from all racks, audio consoles, and grounding point for the area. Each of these grounding conductors shall have a maximum of 0.1 Ohms total resistance.
 - e. Under no conditions shall the AC neutral conductor, either in the power panel or in a receptacle outlet, be used for a system ground
 - 2. No metallic conduit will terminate into the rack cabinet.
 - 3. Audio Cable Shields
 - a. All audio cable shields shall be grounded at one point only. There are no exceptions.
 - b. For inter and intra-rack wiring, this requires that the shield be connected at one end only.
 - c. For ungrounded portable equipment, such as microphones, the shield shall be connected at both ends but grounded at only one end.
 - 4. Audio Receptacles
 - a. All audio receptacles that are provided and installed by the Installing Contractor shall be insulated from the mounting panel, outlet box, or wireway. Unless otherwise detailed herein, this shall be accomplished by using insulated-from-panel type receptacles.
 - 6. Caution
 - a. Because of the great number of possible variations in grounding systems, it shall be the responsibility of the Installing Contractor to follow good engineering practices.

3.3 PERFORMANCE STANDARDS

- .1 Using the proper test equipment the following shall be checked:

1. DC resistance between the rack and equipment.Audio systems functionality.
2. Audio equipment operation.
3. Control system functionality.
4. Control system operation.
5. User interface functionality.
- .2 The Testing Process will continue throughout the Warranty Period of the AV system.

3.4 TEST PROCEDURES

- .1 Calibrated Test Instruments required (minimum)
 1. Sensitive AC voltmeter, -80dBu sensitivity or more, 20Hz -30KHz response, able to measure signal to noise ratio, THD, electrical levels within the system. Note that some systems require measurements up to 100 volts and may require an external pad.
 2. Sound Pressure Level Meter, ANSI Type II, with A and C weighting filters, fast or time averaged.
 3. Audio Signal Generator, 20Hz-30kHz, sine wave, pink noise, and continuous sine wave sweep.
 4. Amplified Loudspeaker 100 mm producing 60 dBa at one meter, and 70 dBa at one meter, pink noise, sine wave, and speech files.
 5. 200Mhz Oscilloscope, with TV sync (analog video only).
 6. Analog Signal Generator NTSC/PAL, plus computer patterns at all required resolutions and refresh rates required for the systems under test. For systems with composite video, include Pluge pattern. (analog video only)
 7. Digital Signal Video Generator for computer patterns for all resolutions and refresh rates required for the systems under test, HDMI/DVI/HD-SDI with and without HDCP.
 8. The ability to measure STI-PA (source analyzer).
 9. Colorimeter/luminance meter, 10% accuracy.
 10. Infrared thermometer.
 11. Test media with known levels (audio, video, etc): Cd's, VS, DVD's etc.
 12. AD/DC multimeter.
 13. Light meter, lux/foot-candles.
 14. Outlet tester (to test power outlet wiring).
 15. The ability to measure electrical power (watt meter, clamp meter, etc).
 16. Cable sets, cable assemblies, adapters as required to sample and measure in-or-out of circuit as req'd.

3.5 STAGING CHECKOUT (PROTOTYPE SHOP CHECKOUT)

- .1 Staging of systems and equipment at the Installing Contractors shop will be done to expedite the on-site installation by allowing the assembly and checkout where the resources are, and prior to the project site being ready.

1. Prototypical system testing for proof of concept in projects with multiple like systems. This will allow the identification and prevention of making the same mistake multiple times.
- .2 Installing Contractor will successfully perform, document, and then submit all the test results to the Owner
- .3 Installing Contractor's test submittal will serve to allow 7-days for the Owner to make arrangements to do Staging Checkout verification
 1. All verification testing is the responsibility of the Installing Contractor. This includes qualified personnel and proper test equipment.
 2. In the event there is required rework, large scale readjustments, or defective equipment that must be repaired or replaced, tests may be suspended or continued at the option of the Owner.
 3. In the event there is required rework, large scale readjustments, or defective equipment that must be repaired or replaced, tests may be suspended or continued at the option of the Owner. Any charge for additional time incurred by the Owner, required to over-see the system tests, due to improper system installation or previous failed systems, shall be the responsibility of, and charged directly to the Installing Contractor.
- .4 Checkout will include:
 1. Appropriate Testing with as many of the various inputs and outputs that can be used to emulate the full system operation
 - a. Ensure there are no equipment problems
 - b. Test as much of the control system operation as possible and to make sure the user interface is intuitive
 2. Inspection
 - a. Workmanship
 - b. Safety related issues
 - c. Serviceability of the system
- .5 Once successful completion of the Staging Checkout has been acknowledged the Installing Contractor can:
 1. for "One-Off" Type of System – Prepare or proceed to the next phase of the installation
 2. for Prototypical – continue the assembly of the other like rooms while testing, documenting and submitting results for each system.

3.6 ON-SITE PROTOTYPE CHECKOUT

- .1 Prototypical system testing for proof of concept in projects with multiple like systems. This will allow the identification and prevention of making the same mistake multiple times.
- .2 Installing Contractor will successfully perform, document, and then submit all the test results to Parks Canada. Installing Contractor's test submittal will serve to allow 7-days for the Owner to make arrangements to do On-Site Prototype Checkout verification
 1. All verification testing is the responsibility of the Installing Contractor. This includes qualified personnel and proper test equipment.
 2. See Section 3.4 Testing and 3.5 Testing Procedures for more details on testing and testing procedures

3. AV Consultant will be responsible to note any minor infractions on a "punch list" and Installing Contractor will be responsible for fixing these items before next checkout phase.
4. In the event there is required rework, large scale readjustments, or defective equipment that must be repaired or replaced, tests may be suspended or continued at the option of the Owner. Any charge for additional time incurred by the Consultant required to over-see the system tests, due to improper system installation or previous failed systems, shall be the responsibility of, and charged directly to the Installing Contractor
- .3 Checkout will include:
 1. Appropriate Testing with all field cables and connections made, and all equipment operational.
 - a. Insure there are no equipment and field wire problems
 - b. Test the complete control system operation and to make sure the user interface is intuitive
 2. Inspection
 - a. Workmanship
 - b. Safety related issues
 - c. Serviceability of the system
- .4 Once successful completion of the On-Site Prototype Checkout has been acknowledged the Installing Contractor can continue the build-out of the other like rooms.

3.7 FULL SYSTEM COMMISSIONING

.1 Installing Contractor's Full System Checkout

1. Installing Contractor will accomplish a complete system(s) inventory of all equipment, and inspection of all workmanship quality relating to installation details.
2. Installing Contractor will complete all testing for system operational compliance, and test to ensure all equipment is working fully to published specifications.
3. Results will be recorded and submitted to the Owner. Installing Contractor's commissioning submittal will serve to allow 7-days for the Owner to perform an Owners System commissioning.
4. A physical inventory will be taken of all equipment on site and will be compared to equipment lists in the contract documents and subsequent Installing Contractor submittals.
5. The operation of all system equipment shall be demonstrated by the Installing Contractor.
6. Both subjective and objective tests will be required to determine compliance with the specifications.
 - a. The Installing Contractor shall be responsible for providing test equipment for these tests.
 - b. The Installing Contractor shall be responsible for providing qualified personnel to run the tests, make adjustments, and answer system questions for as long as required to accomplish the tests and setup satisfactorily.

7. The Installing Contractor shall be responsible for providing the personnel that accomplished all programming for the system; this includes the control system and any DSP software. This person will be available to run requested demonstration, make adjustments, and answer system programming questions for as long as required to accomplish the demonstration satisfactorily.
8. In the event there is required rework, large scale readjustments, or defective equipment that must be repaired or replaced, tests may be suspended or continued at the option of the Owner. Owner will advise if training can commence while any further cleanup is being done before Final System Checkout.

3.8 TRAINING

- .1 The Installing Contractor shall provide on-the-job training by a qualified instructor, to personnel designated by the Owner, to instruct them in the operation and routine maintenance of the systems.
 1. All training shall take place after the systems are operational, but before the acceptance tests.
 2. Operational Training:
 - a. There shall be a minimum of 2 hours of end-user training included in this specification for this activity.
 - b. In the event the Installing Contractor does not have qualified instructors on staff for certain sophisticated equipment, the Installing Contractor, at no additional cost to Owner, will provide a manufacturer's representative for such instruction to the Owner.
 - c. Training Materials Supplied:
 - (a) System operational manual (not equipment operation manuals) that explains how to fully operate the system; from start-up to shut-down, and all operational steps in-between, in a step by step description, with pictures and other visuals to help convey information.
 3. Maintenance Training:
 - a. A session with Owner's designated technical personnel for routine and preventive maintenance will be given.
 - (a) This training is for scheduled preventative maintenance for such items as filter and lens cleaning, minor equipment checks and "user" adjustments.
 - (i) This training is not meant to teach Owner's representatives how to use commercial test equipment and/or do sophisticated equipment/system alignment.
 - b. There shall be a minimum of 2 hours of end-user training included in this specification for this activity.
 - c. Training Materials Supplied:
 - (a) Utilizing the equipment manuals and flow diagrams of the required in contract closeout submittals supply a listing with suggested preventative maintenance schedule of the system equipment.

3.9 FINAL CHECKOUT

- .1 Final Checkout will not be performed until the Installing Contractor's Full System Commissioning has been successfully completed (including all "punch-list" items) and the test results have been reviewed by the Owner.
 1. Installing Contractor's test submittal will serve to allow 7-days for the Owner to make arrangements to do Final Checkout

.2 The Final Checkout with the Owner will consist of the following:

1. A physical inventory will be taken of all equipment on site and will be compared to equipment lists in the contract documents and subsequent Installing Contractor submittals.
2. The operation of all system equipment shall be demonstrated by the Installing Contractor.
3. Both subjective and objective tests will be required to determine compliance with the specifications. The Installing Contractor shall be responsible for providing test equipment and qualified personnel for these tests.
4. All final, "as-built" drawings, run sheets, manuals, and other required documents shall be on hand.
 - a. Two complete sets of these documents shall be delivered to Parks Canada at this time.

END OF SECTION

1. General

1.1 RELATEDWORK

- .1 Testing, Adjusting and Balancing of Electrical Equipment and Systems Section 26 01 26
- .2 Electrical Equipment and Systems Demonstration and Instruction Section 25 05 83

1.2 COORDINATION

- .1 Coordinates starting of electrical equipment and systems with testing, adjusting and balancing, and demonstration and instruction of:
 - .1 Electrical equipment and systems specified in Division 26.
 - .2 Mechanical equipment and systems specified in Division 23.
 - .3 Other equipment and systems specified in other Divisions.
- .2 Where any equipment or system requires testing, adjusting or balancing prior to starting, ensure that such work has been completed prior to starting of electrical equipment and systems.

2. Products

- .1 Not Used

3. Execution

3.1 ENERGIZING MAIN ELECTRICAL SYSTEM

- .1 Prior to energizing main electrical system:
 - .1 Verify supply authority voltage and phase rotation.
 - .2 Close and open all devices to ensure proper mechanical operation.

3.2 STARTINGMOTORS

- .1 Prior to starting motors:
 - .1 Verify phase rotation at motor control centres.
 - .2 Confirm motor nameplate data with motor starter heater overloads.

3.3 ENERGIZING EQUIPMENT

- .1 Prior to energizing equipment provided under other Sections and equipment provided by the Owner.
- .2 Confirm equipment nameplate data with characteristics of power supply.

END OF SECTION

1. General**1.1 INTENT**

- .1 Except where otherwise specified, arrange and pay for testing, adjusting, balancing and related requirements specified herein.
- .2 If test results do not conform with applicable requirements, repair, replace, adjust or balance equipment and systems. Repeat testing as necessary until acceptable results are achieved.
- .3 Provide all labour, materials, instruments and equipment necessary to perform the tests specified.
- .4 All tests shall be witnessed by persons designated by the Owner, who shall also sign the test documentation.
- .5 Submit procedures proposed in writing for approval two (2) weeks prior to test.

1.2 RELATED REQUIREMENTS

- .1 Electrical Operation and Maintenance Data Section 26 05 01
- .2 Starting of Electrical Systems and Equipment Section 26 01 25

1.3 MANUFACTURER'S PRODUCTION TEST RECORDS

- .1 If requested, submit copies of production test records for production tests required by EEMAC and CSA standards for manufactured electrical equipment.

1.4 SITE TESTING REPORTS

- .1 Log and tabulate test results on appropriate test report forms.
- .2 Submit forms to Owner for approval prior to use.
- .3 Submit completed test report forms as specified, immediately after tests are performed. Final test report to be included in electrical O&M Manuals.

1.5 REFERENCE DOCUMENTS

- .1 Perform tests in accordance with:
 - .1 The Contract Documents
 - .2 Requirements of authorities having jurisdiction
 - .3 Manufacturer's published instructions
 - .4 Applicable CSA, IEEE, IPCEA, EEMAC and ASTM standards
- .2 If requirements of any of the foregoing conflict, notify A/E before proceeding with test and obtain clarification.

1.6 MANUFACTURER'S SITE SERVICES

- .1 Arrange and pay for the site services of appropriately qualified manufacturer's representatives where site testing, adjusting, or balancing of electrical equipment or systems' performed by Manufacturer's representatives is:

- .1 Specified, or
- .2 Otherwise required to ensure that electrical equipment and systems are operational in full compliance with the Contract Documents

1.7 SEQUENCING AND SCHEDULING

- .1 Except where otherwise specified, perform all testing, adjusting, balancing and related requirements specified herein prior to Interim Acceptance of the Work.
- .2 Perform voltage testing and adjusting after user occupancy or utilization of facility.

2. Products**2.1 TEST EQUIPMENT**

- .1 Provide all equipment and tools necessary to perform testing, adjusting and balancing specified herein and as otherwise required.

3. Execution

3.2 TESTING OF WIRING AND WIRING DEVICES

- .1 All power and control wiring shall be tested for insulation resistance value with a 1000 volt megger. Resistance values shall be as recommended by cable manufacturer. Test results shall be properly tabulated, signed, dated and submitted with maintenance manuals.
- .2 Test service grounding conductors for ground resistance.
- .3 Test all wiring devices for correct operation.
- .4 Test all receptacles for proper polarity and circuitry.

3.3 LOAD BALANCE TESTING

- .1 Perform load tests when as many loads as possible, prior to Interim Acceptance of the Work, are operable.
- .2 Turn on all possible loads.
- .3 Test load balance on all feeders at distribution centres, motor control centre and panelboards.
- .4 If load balance exceeds 15%, reconnect circuits to balance loads, update as built.

3.4 VOLTAGE TESTING AND ADJUSTING

- .1 Test voltage at all panelboards.
- .2 Test voltage at motor control centre.
- .3 Adjust transformer tap settings to compensate for under-voltage or over-voltage conditions, if directed to do so by A/E.
- .4 Confirm phase rotation and colour coding of conductors at the main switchboard, all panelboards and motor control centres.

END OF SECTION

1. General

1.1 WORK INCLUDED

- .1 Complete and operational electrical system as required by the drawings and as herein specified.

1.2 RELATED WORK

- | | | |
|----|----------------------|------------------|
| .1 | General Requirements | Section 01 00 00 |
| .2 | Site Work | Section 31 00 00 |
| .3 | Concrete | Section 03 00 00 |
| .4 | Doors and Windows | Section 08 00 00 |
| .5 | Finishes | Section 09 00 00 |
| .6 | Specialties | Section 10 00 00 |
| .7 | Equipment | Section 11 00 00 |
| .8 | Mechanical | Section 23 00 00 |

1.3 DRAWINGS AND SPECIFICATIONS

- .1 The General Conditions, Supplementary Conditions and Division 1 are a part of this specification and shall apply to this Division.
- .2 The intent of the drawings and specifications is to include all labour, products and services necessary for complete work, tested and ready for operation.
- .3 Mention herein or indication on the drawings, of articles, materials, operations or methods requires that all such items shall be supplied in the quality and quantity required, and that the operations shall be performed according to the methods prescribed, complete with all necessary labour and incidentals.
- .4 These specifications and the drawings and specifications of all other divisions shall be considered as an integral part of the accompanying drawings. Any item or subject omitted from either the specifications or the drawings but which is mentioned or reasonably specified in and by the others, shall be considered as properly and sufficiently specified and shall be provided. Also refer to 3.2 (this section) coordination with other divisions.
- .5 Provide all minor items and work not shown or specified but which are reasonably necessary to complete the Work.
- .6 If discrepancies or omissions in the drawings or specifications are found, or if intent or meaning is not clear, advise the Owner for clarification before submitting tender.
- .7 Responsibility to determine which Division provides various products and work rests with the Contractor. Additional compensation will not be considered because of differences in interpretation of specifications.

1.4 QUALITY ASSURANCES

- .1 Codes, Rules, Permits & Fees
 - .1 Comply with all laws, ordinances, rules, regulations, codes and orders of all authorities having jurisdiction relating to this work.
 - .2 Comply with all rules of the Electrical Protection Act of BC, CSA Standards and Canadian Underwriters Laboratories and the applicable building codes, whether specifically shown on drawings or not.
 - .3 Quality of work specified and/or shown on the drawings shall not be reduced by the foregoing requirements.
 - .4 Immediately after award of contract and prior to installation, verify location, arrangement and point of attachment for service and service entrance equipment with supply authority and inspection departments. Failure to do so will render this Division responsible for any corrections necessary without additional compensation.
 - .5 Give all required notices, submit drawings, obtain all permits, licenses and certificates and pay all fees required for this work.
 - .6 Furnish a Certificate of Final Inspection and approvals from inspection authority to the Owner.
- .2 Standards of Workmanship
 - .1 Execute all work in a competent manner and to present an acceptable appearance when completed.
 - .2 Employ a competent supervisor and all necessary licensed tradesmen to complete the Work in the required time.
 - .3 Arrange and install products to fit properly into designated building spaces.
 - .4 Unless otherwise specified or shown, install products in accordance with recommendations and ratings of manufacturers.

1.5 SUBMITTALS

- .1 Refer to architectural specifications.

1.6 RECORD DRAWINGS

- .1 Maintain on site a complete set of as-built drawings as listed in General Conditions and as follows. Before commencing work, obtain a set of white prints of all drawings pertinent to the work. Keep record drawings on site and continuously update to accurately record in coloured pencil all items such as change orders, alterations or Facility's, runs of conduit, numbers and location of outlets, motors, panels and luminaires that may occur during the progress of the work.
- .2 Before substantial performance is granted to this Contractor, neatly transpose this information onto a set of full size white paper set of drawings in red and coloured ink. All conduit runs and junction boxes larger than 150 mm square must be shown on the Record Drawings, complete with size and wire count. Provide one (1) complete printed set and colour scanned version.
- .3 Before requesting final certificate, make any necessary final corrections, sign each print as a certification of accuracy and deliver all sets to the Owner.

1.7 OPERATIONS AND MAINTENANCE MANUALS

- .1 Before requesting final certificates, submit two complete sets of the operating/maintenance manuals, as specified in the General Conditions. Refer to Section 01781.
- .2 Binders: Extension type catalogue binders bound with heavy fabric, hot stamped in gold lettering front and spine, sized for 216 mm (8 ½") x 279 mm (11") paper. Binders must not exceed 76 mm (3") thick or be more than 2/3 full. Binder colour to be yellow with the lettering on the front spine to read:
 - Project Title
 - Date Submitted
 - Project Location
 - Manual Title
 - Volume Number
 - Project Number
- .3 Each manual shall contain:
 - Table of contents. Arrange contents sequentially by systems under section numbers. Label tabs of dividers between each to match section numbers in table of contents.
 - Tabs are to be celluloid covered fastened to hard paper dividing sheets.
 - List the electrical engineering firm and electrical contractor with names, addresses and telephone numbers of contacts.
 - Systems Descriptions. A brief synopsis of each system typed and inserted at the beginning of each section. Include sketches and diagrams where appropriate.
 - Descriptive and technical data to follow the general layout of the specifications.
 - Maintenance and operating instructions for all electrical equipment and controls. (These operating instructions need not be manufacturer's data but may be typewritten instructions in simple language to guide the Owner in the proper operation and maintenance of his installation.)
 - Lubricating and servicing intervals recommended.
 - A copy of all wiring diagrams complete with wire coding.
 - List of spare parts of all electrical equipment complete with names, addresses, and telephone numbers of sales, service representatives and suppliers.
 - Copy of test data
 - A motor list showing each motor number, name, horsepower, nameplate, current rating, heater size and type, and current being drawn, on the form specified in Section 26 05 82.
 - Include type and accuracy of instruments used.
 - Copy of final inspection certificate.
 - Set of final reviewed Shop Drawings.
- .4 Electrical Operation and Maintenance Manuals are to be organized.

1.8 PRODUCT HANDLING

- .1 Use all means necessary to protect the products of this Division before, during and after installation and to protect products and installed work of all other trades.
- .2 Immediately make good any damage by repair or replacement at no additional cost to the Owner and to the approval of the Owner.
- .3 Remove advertising labels from fixtures, conduit, panelboards, etc. Do not remove identification or CSA labels.

- .4 Remove dirt, rubbish, grease, etc. resulting from this work from all surfaces.

1.9 ALTERNATE AND SEPARATE PRICES

- .1 In accordance with the Instructions to Bidders, state on the Tender Form in the space provided, the amount to be deducted from the base bid tender amount for the use and installation of equipment as an alternate to those specified and the requested separate prices.

1.10 GUARANTEE

- .1 Furnish a written guarantee to the Owner prior to final contract payment, which will be in effect for one year from the date of final acceptance of the complete work. Replace or repair at no cost to the Owner any defective material or workmanship except where, in the opinion of the Owner, such defects are due to the misuse or neglect by the Owner.
- .2 This general guarantee shall not act as a waiver of any specified or special equipment guarantees which cover a greater length of time.

1.11 PROGRESS CLAIMS

- .1 Within thirty (30) days after award of contract, a breakdown of material and equipment items including labour and expense components shall be compiled on the Owner format. Subsequent requests for payment shall be documented accordingly.

1.12 WORKSCHEDULE

- .1 Install work to facilitate installation and servicing of indicated future work.
- .2 Work shall be done in phases as described in Architectural.
- .3 Layout electrical work to allow for phasing of work. Refer to architectural for breakdown of phases and for construction schedule regarding phasing.

1.13 FOR ENGINEERS SERVICES

- .1 Division 26 to include, for all costs to provide construction related engineering services specified herein.
- .2 These services include, but are not limited to:
 - .1 All costs for additional engineering services during construction as a result of the following:
 - .1 Re-inspection due to incomplete or defective work.
 - .2 Contractor caused delays during normal testing and inspection procedures.

2. Products

2.1 SELECTED PRODUCTS AND EQUIVALENTS

- .1 Products and materials provided shall be new and free from all defects. Related materials shall be of the same manufacturer throughout the project.

- .2 Products and materials called for on the drawings or in the specifications by trade names, manufacturer's name and catalogue reference are those which shall be used as the basis for the Tender.
- .3 The design has been based on the use of the first named product.

2.2 ALTERNATIVE PRODUCTS

- .1 Alternative products and materials to those specified shall only be considered if they are shown in the Tender as a material variation with an appropriate price adjustment. The Owner reserves the right to accept or reject any alternative without explanation.
- .2 Submission shall provide sufficient information to enable the Owner to determine acceptability of such products. Submission to be submitted seven (7) days before close of tender.
- .3 Provide complete information on required revisions to other work and products to accommodate each alternate product, and the amount of Facility or reduction from tender amount, including required revisions, for each alternate product.
- .4 Assume full responsibility for ensuring that when providing alternative products or materials, all space, weight, connections, power and wiring requirements etc. are considered. Any costs incurred for additional components, changes to services, structural or space requirements, layouts and plans, etc. that may be necessary will be borne by the contractor.
- .5 Unless a proposal for an alternative product is submitted in this manner and later accepted, provide the product specified.
- .6 Materials or equipment rejected by the Owner shall be immediately removed from the project and suitable materials shall be provided.
- .7 Prior approval to submit a proposal for an alternative product with the Tender is not required.

2.3 REVIEW OF PRODUCTS

- .1 Immediately after notification of award of contract, review with the Owner a list of products proposed, including any alternatives submitted with tender.
- .2 After agreement on product list, no subsequent changes will be permitted except as specified hereafter.

2.4 SUBSTITUTION OF PRODUCTS AFTER CONTRACT AWARD

- .1 After acceptance of the list of products, no substitution of any item will be permitted unless the approved item cannot be delivered in time to comply with the work schedule.
- .2 To receive acceptance, proposed substitutes must equal or exceed the quality, finish and performance of those specified and/or shown, and must not exceed the space requirements allotted on the drawings.
- .3 Provide to the Owner documentary proof of equality, difference in price (if any) and delivery dates, in the form of certified quotations from suppliers of both specified items and proposed substitutions.
- .4 Include costs for any required revisions to other structures and products to accommodate such substitutions.

2.5 QUALITY OF PRODUCTS

- .1 All products provided shall be CSA Approved, Canadian Underwriters' Laboratory approved where applicable, and new, unless otherwise specified.
- .2 If products specified are not CSA approved, obtain approval of provincial regulatory authority. Pay all applicable charges levied and make all modifications required for approval.
- .3 Products provided, if not specified, shall be new, of a quality best suited to the purpose required and their use subject to approval by the Owner.

2.6 UNIFORMITY OF MANUFACTURE

- .1 Unless otherwise specifically called for in the Specifications, uniformity of manufacture shall be maintained for similar products throughout the work.

2.7 PRODUCT FINISHES

- .1 Finish all cabinets, panelboards, switchboards, equipment cabinets, cable trays, etc. in ANSI 61 grey enamel unless otherwise specified.
- .2 Apply primer on all items which are to be finished on the job.
- .3 Touch up all damaged painted finishes with matching lacquer, or, if required by the Owner, completely repaint damaged surface.

2.8 USE OF PRODUCTS DURING CONSTRUCTION

- .1 Any equipment used for temporary or construction purposes shall be approved by the Construction Manager and in accordance with the General Conditions, "Use of Premises." Clean and restore to "as new" condition all equipment prior to the time of substantial completion.
- .2 The warranty period shall not begin until the date of substantial performance of the work.

3. Execution**3.1 SITE EXAMINATION**

- .1 Examine the site of work and become familiar with all features and characteristics affecting this work before submitting tender.
- .2 No additional compensation will be given for extra work due to existing conditions which such examination should have disclosed.
- .3 Report to the Owner any unsatisfactory conditions which may adversely affect the proper completion of this work.

3.2 COORDINATION WITH OTHER DIVISIONS

- .1 Examine the drawings and specifications of all divisions and become fully familiar with their work. Before commencing work, obtain a ruling from the Owner if any conflict exists, otherwise no additional compensation will be made for any necessary adjustments. Also refer to item 1.3.4 this section.
- .2 Fully understand the functions of the systems specified and have no doubts with regard to the extent of the Contract.

-
- .3 Coordinate with all Divisions installing equipment and services, and ensure that there are no conflicts.
 - .4 Install anchors, bolts, pipe sleeves, hanger inserts, etc. in ample time to prevent delays.
 - .5 Lay out the work and equipment with due regard to architectural, structural and mechanical features. Architectural and structural drawings take precedence over electrical drawings regarding locations of walls, doors and equipment.
 - .6 Do not cut structural members without approval of the Owner.

3.3 LOCATION OF OUTLETS AND LUMINAIRES

- .1 Electrical drawings are, unless otherwise indicated, drawn to scale and approximate distances and dimensions may be obtained by scaling. Figured dimensions shall govern over scaled dimensions. Where exact dimensions and details are required, refer to Architectural and Structural drawings.
- .2 Outlet and equipment locations shown on the drawings are approximate. Locations may be revised up to 3 meters to suit construction and equipment arrangements without additional cost to the Owner, provided that installation has not been completed.
- .3 Maintain luminaire locations wherever possible. Notify the Owner of conflicts with other services.
- .4 Unless otherwise specified or shown, install products in accordance with recommendations and ratings of manufacturers.

3.4 SEPARATION OF SERVICES

- .1 Maintain separation between electrical wiring system and building piping, ductwork, etc. so that wiring system is isolated (except at approved connections to such systems) to prevent galvanic corrosion.
- .2 In particular, contact between dissimilar metals, such as copper and aluminum, in damp or wet locations is not permitted.
- .3 Do not support wiring from pipes, ductwork, etc. Hangers for suspended ceilings may be used for the support of wiring only when approval is obtained from the Owner and the ceiling installer, and approved clips or hangers are used.

3.5 IDENTIFICATION

- .1 Clearly mark all exposed conduit, junction boxes, etc., to indicate the nature of service.
- .2 Provide neatly typed circuit directories in panelboards to indicate the area or equipment controlled by each branch circuit.
- .3 All conductors shall be identifiable by coloured insulation and permanent markers at every terminal and accessible points throughout its entire run.
- .4 All exposed feeder conduits for all systems and all control conduits shall be clearly identified at all pull box locations.

-
- .5 Conductor s:
- Equipment Grounding - Green
- Neutral Conductor - White
- | <u>120/208 Volt System</u> | <u>347/600 Volt System</u> |
|----------------------------|----------------------------|
| Phase A - Red | Phase A - Orange |
| Phase B - Black | Phase B - Brown |
| Phase C - Blue | Phase C - Yellow |
- .6 Low Voltage Wiring: per manufacturer's standard, i.e. PDM low voltage relay switching system.
- .7 All colours referred to in the above paragraphs shall be as follows:
- | | |
|--------|---|
| Grey | Canadian General Standards Board #501-107 Grey |
| Green | Canadian General Standards Board #503-211 Apple Green |
| Blue | Canadian General Standards Board #202-101 Dark Blue |
| Red | Canadian General Standards Board #509-102 Red |
| Bronze | Canadian General Standards Board #514-101 Bronze |
| Brown | Canadian General Standards Board #504-104 Brown |
- .8 Submit paint chips for approval for all colours referred to in the above paragraphs prior to manufacture of equipment.
- .9 Pull Boxes and Conduit:
- Conduit as indicated previously and one conduit entering or leaving a pull box shall be identified as follows:
- 120/208V: Red background with black letters "120/208V"
- Telephone System: Green background with black letter "T"
- Low Voltage Control Circuits: Black background with black letters "TV"
- Television Distribution: Green background with black letters "TV"
- Use Brady self-sticking identification tape, or approved equal. The use of "Dymo" tape identification is not acceptable.

3.6 WIRING TO EQUIPMENT SUPPLIED BY OTHERS

- .1 Equipment supplied by the Owner or under other Division will be moved to the installation site by others. However, the electrical connection to the equipment shall be done by this Division.
- .2 It is the responsibility of this Division to ensure that all wiring, connectors, branch circuit breakers, etc. are sized to and match the equipment provided.

3.7 TESTING

- .1 Refer To Section 26 01 26

3.8 SINGLE LINE DIAGRAM

- .1 Provide and mount a framed as-built single line diagram at the main electrical equipment. Use a clear plexiglass cover. The diagram shall be 914 mm x 600 mm minimum, with all lettering Leroyed.

3.9 INSTRUCTIONS TO OWNER'S PERSONNEL

- .1 Refer To Section 26 05 83

3.10 ACCESS PANELS

- .1 Where electrical equipment, junction boxes, remote ballasts or the like are concealed, access panels shall be supplied. Panels shall be of adequate size for servicing of the electrical work and complete with necessary frames and hinged doors held closed with captive fasteners. Coordinate type and size of panels with the Owner.
- .2 In removable ceiling areas, provide markers on ceiling tile to locate equipment requiring access. Markers shall be of a type approved by the Owner.

3.11 MOUNTING HEIGHTS

- .1 Unless a conflict exists, use the following as mounting heights from finished floors:

Data Receptacles	787 mm to centre of outlet
Data Outlets	787 mm to centre of outlet
Receptacles in Mechanical Rooms	1,070 mm to centre
Receptacles & Telephone Outlets	1070 mm to centre
Light Switches	1,220 mm to centre
Clocks	2,300 mm
Panels and Starters to top of cover	1,870 mm
End of Line Resistors (maximum)	1525 mm (maximum 1800mm)
Receptacles & Telephone Outlets above counters	150 mm above countertop or 150 mm above splash bar
Emergency Lighting Remote Heads	2,300 mm or 2,800 mm in high ceiling areas or as indicated on drawings
Power Receptacle supporting data outlet	460 mm to bottom of outlets
Classroom Telephones	1500 mm to centre

3.12 SEALING OF WALLS AND FLOOR OPENINGS

- .1 All conduit and cable entries through outside walls of buildings, through partition walls separating electrical rooms from other areas, through fire separations, and through floors above grade shall be sealed to prevent passage of moisture, dust, gasses, flame, or to maintain pressurization.
- .2 Openings shall be sealed when all wiring entries shown on the drawings have been completed.
- .3 Sealing material shall be fire resistant and shall not contain any compounds which will chemically affect the wiring jacket or insulating material. Cable penetrations through fire separations to be sealed in accordance with Section 26 05 01.

3.13 FIRE PROTECTION OF ELECTRICAL CONDUCTORS

- .1 Fire rated access panels shall be provided in the enclosures where required.

- .2 The fire rated enclosures required by this Division shall, unless otherwise noted, be by this Division and shall be in accordance with the sections of the specification detailing the fire rated enclosures requirements.
- .3 Advise the extent of the fire rated enclosures required and supply all information and details as to size and locations within thirty days after the award of the contract.
- .4 Failure to comply with the above requirements shall be remedied at this Division's expense.
- .5 Where fire rated cables that comply with the requirements of the Authorities having jurisdiction are provided, it shall not be required that they be installed in fire rated enclosures.

3.14 HOUSEKEEPING PADS

- .1 All floor mounted electrical equipment installed by this Division shall be mounted on concrete housekeeping pads which shall, unless otherwise noted, be by this Division.
- .2 Advise the extent of the housekeeping pads required and supply all information and details as to size and locations within thirty days after the award of the Contract.
- .3 Failure to comply with the above requirements shall be remedied at this Division's expense.

3.15 SLEEVES

- .1 Provide sleeves of galvanized steel pipe with machine cut ends of ample size to accommodate conduits passing through walls, partitions, ceilings, floors, etc.
- .2 For wall, partitions and ceilings the ends shall be flush with the finish on both sides but for floors they shall extend 4" above finished floor level.
- .3 The space between the sleeve and the conduit shall be filled with Dow Corning silicone RTV foam for fire stop and caulked around the top and bottom with approved permanently resilient, non-flammable and weatherproof silicone base compound and ensure that the seal is compatible with the floor and ceiling finishes.
- .4 Locate and position sleeves exactly prior to construction of walls, floors.
- .5 Failure to comply with the above requirements shall be remedied at this Division's expense.

3.16 PRICEBREAKDOWN

- .1 The successful bidder shall, following award of contract, give a breakdown of the tender price as follows:
 - .1 Electrical distribution equipment and feeders.
 - .2 Emergency distribution system including emergency and exit lights.
 - .3 Lighting, branch circuit wiring and controls.
 - .4 Mechanical equipment, power and control wiring.
 - .5 Miscellaneous power and branch circuit wiring (indicate items included).
 - .6 Telephone/Data raceway and wiring system.
 - .7 Intercommunication/Security Conduit Systems

3.17 EQUIPMENT STORAGE AND PROTECTIONS

- .1 Deliver equipment in original wrapping or containers, with manufacturer's label and seals intact.
- .2 Handle and store equipment in accordance with manufacturer's recommendations and prevent damage, inclusion of foreign matter, rusting, staining and defects which will affect performance and appearance.
- .3 Equipment containing components such as open bussing, contacts and solid state devices to be adequately and continuously protected in an enclosed, dry and dust-free environment while in transit, during installation and until completion of the Contract. The Owner may not accept repair of defective equipment if the above is not observed.

3.18 WORKMANSHIP

- .1 Workmanship to be of a high standard throughout.
- .2 Exposed conduit runs to be perpendicular or parallel to the building lines as necessary. Panels, boxes, covers, etc. shall be mounted in a similar manner. These conditions to be determined using spirit levels.
- .3 Bolts or nuts in a "stripped" or "cross threaded" condition to be replaced immediately.

3.19 COST BREAKDOWN

- .1 Submit to the Owner at time of award of Tenders a cost breakdown of the contract amount for the items described on sheet provided.

3.20 CLEANING

- .1 Do final cleaning in accordance with Division 01 requirements.
- .2 At time of final cleaning, lighting reflectors, lenses, and other lighting surfaces that have been exposed to construction dust and dirt shall be cleaning using soft clothes and approved cleansers.
- .3 Vacuum out all panelboard, cabinet and enclosure tubs and clean all equipment surfaces so they are free of construction dirt and paint.

3.21 YEAR COMPLIANCE

- .1 All products and equipment utilized on this project shall be designed and able to manage dates of more than one century, providing correct dates and times into the 21st century and beyond, including correct leap year calculations.
- .2 The Contractor shall provide testing protocols to confirm their equipment is fully Y2K and Y2K38 (Year 2038) compatible and other potential year with known computing issues (e.g., 2070).
- .3 The Contractor shall agree to repair, replace, or upgrade at not cost to the Owner any failure to comply with these warranties and to reimburse and indemnify the Owner against liabilities or losses it may suffer as a result of such failure.

EMBE Electrical Specification

Project Name: Rogers Pass Washroom Facility

EMBE Project No.: 17-274

Section 26 05 00 ELECTRICAL GENERAL

REQUIREMENTS

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3.23 PROGRESS BREAKDOWN

DESCRIPTION	CONTRACT AMOUNT	COMPLETED TO DATE	% COMPLETE	PREVIOUS COMPLETE	AMOUNT THIS CLAIM
Intrusion Alarm System					
Electrical Distribution					
Emergency Distribution					
Lighting Fixtures					
MCC Equipment					
Misc. Power & Branch Circuit					
Telephone, Computer, CATV Wiring & Raceways					
Miscellaneous					
TOTAL					

END OF SECTION

1. General**1.1 WORK INCLUDED**

- .1 Provide a complete system of wiring, making all connections necessary for the installation shown on drawings.

1.2 SPECIAL CODES

- .1 Install and rate power cables in accordance with the Canadian Electrical Code requirements, or in accordance with IPCEA requirements where permissible.

2. Products**2.1 WIRE**

- .1 Conductors outdoors or in wet areas. X-Link: 98% conductivity copper conductors sized as indicated with 600 volt insulation of chemically cross-linked thermosetting polyethylene material, rated RW90 and RWU-90.
- .2 Conductors indoors. X-Link: 98% conductivity copper conductors sized as indicated with 600 volt insulation of chemically cross-linked thermosetting polyethylene material, rated RW90 and RWU-90. Or nylon jacketed thermoplastic insulation type T90 Nylon rated at 600V.
- .3 Luminaire Wire: Copper conductors, #12 A.W.G. with thermoplastic and asbestos insulation type TEW, flame retardant, heat and moisture resistant, rated 600 volts, 105°C.
- .4 Thermoplastic: Copper conductors, #12 AWG with thermoplastic insulation types X-Link, rated at 600 volts.
- .5 Conductors: Stranded for # 8 AWG or larger.

2.2 WIRECONNECTORS

- .1 Use 3M "Scotchlock," or ideal self-insulated connectors for hand twist wire joints for lighting, small power, and control wiring.
- .2 Use T & B non-insulated ring type compression lugs for terminating #10 AWG and smaller motor connections. Tape with rubber and scotch tape. Lugs to accept ten - 32 x 3/8" machine bolts.
- .3 Terminate conductors #8 AWG and larger with Thomas & Betts Colour-Keyed compression connectors Series 54000, or on lugs provided with equipment.
- .4 Thomas & Betts "KOPR-SHIELD" compound Series CP8 on all terminations for compression connectors.
- .5 Wiring device connections, follow the "good installation practice" of pigtail both the "hot" and the neutral conductors of electrical devices, such as receptacles, so that removal of a device (while lines are hot) cannot result in the disconnection of downstream devices from power nor expose the electrical working to line-to-line voltages that would result from a neutral disconnection.

2.3 ARMoured CABLE

- .1 Conductors: Insulated copper size as indicated, Armour: Interlocking fabricate from aluminum strip.
- .2 Type: AC90

2.4 COMMUNICATION CABLES:

- .1 Structured Communication Cabling to section 27 10 00
- .2 Security Intrusion and Access Control to section 28 16 00

3. Execution**3.1 GENERAL**

- .1 X-Link: for all wiring except as specified below. All conductors to be rated RW90 copper unless otherwise shown.
- .2 RW90 for branch circuit conductors, #12 AWG or larger. Use #10 AWG for 120 volt home runs over 30 meters.
- .3 Minimum #14 AWG flexible stranded copper for controls and #12 AWG solid copper for branch circuit power and lighting.
- .4 Luminaire Wire: run wires from outlet boxes through luminaire raceways, splice and connect in raceways. Connect continuous rows of luminaires to circuit without breaking conductors.
- .5 Insulation is to be rated for a minimum of 600VAC unless specified otherwise. Conduit sizes are based on 600V insulation. Adjust conduit size as required for insulation greater than 600VAC.
- .6 Use copper conductors for all feeders. Panel, motor control centres and distribution board feeders may be aluminum alloy if 100 amps or larger.

3.2 WIRECONNECTORS

- .1 Select hand twist connectors for wire size and install tightly on conductors.
- .2 Brush "KOPR-SHIELD" compound on terminations for compression connectors as recommended by the manufacturer.
- .3 Install compression connectors using methods and tools recommended by manufacturer.
- .4 Do not install stranded conductors under screw terminals unless compression lugs are installed.

3.3 WORKMANSHIP

- .1 Before pulling wire, ensure conduit is dry and clean. If moisture is present, thoroughly dry out conduits; vacuum if necessary. To facilitate pulling, recognized specially manufactured wire pulling lubricants may be used. Do not use grease. Employ suitable techniques to prevent damage to wire when ambient temperature is below the minimum permitted for each insulation type. Do not pull wires into incomplete conduit runs.
- .2 Installation to be free of opens and grounds. Before energization, measure insulation resistance and comply with Table 24 of the C.E.C., Part 1. Submit data sheet with values measured.
- .3 Do not install any conductor smaller than #12 AWG, except where specifically indicated otherwise, i.e. for P.A. wiring, etc.
- .4 Provide sizes of conductors as shown on drawings. Voltage drop from branch panels to farthest outlet must not exceed 3% at full load in any case. Advise Owner if problem is foreseen. Voltage drop for conductors from main distribution to branch circuit panelboards shall not exceed 2% under full load conditions.
- .5 Exercise care in stripping insulation from wire. Do not nick conductors.

3.4 IDENTIFICATION, CODING AND BALANCING

- .1 For branch circuit wiring, follow identification system shown on the drawings and as specified in Section 26 05 01.3.5, Identification.
- .2 Connect single phase equipment to minimize imbalance on feeders. Adjust branch circuiting shown as required for optimum balancing. Record all changes on "record" drawings.
- .3 Colour code all feeders at all terminations, at all points where taps are made, and at all panelboards, switchboards, motor control centres, etc. Use two wraps of 3M #471 plastic film tape 48 mm wide.
- .4 Conductors sized No. 10 and smaller are required to be factory coloured, not taped on site.
- .5 For direct current wiring use red for positive and black for negative.

3.5 INSTALLATION OF ARMOURED CABLE:

- .1 Minimum wire size shall be AWG# 12.
- .2 Armoured cable may be used for:
 - .1 Final connection to luminaires not exceeding 1.5 m in length.
 - .2 Connection of wiring devices located in millwork.
 - .3 Runs contained in metal or wood stud containing only one or two circuits. Power must be brought first to a junction box within an individual room in conduit. Up to two circuits can be taken from that junction box with in that room using armoured cable.

3.6 TESTING

- .1 All power and control wiring shall be tested for insulation resistance value with a 1000 volt megger. Resistance values shall be as recommended by the cable manufacturer.
- .2 All wire test results shall be properly tabulated, signed, dated, and submitted to the Owner.

END OF SECTION

1. General

1.1 DESCRIPTION

- .1 Supply and install a complete grounding system. Securely and adequately ground all components of the electrical system in accordance with the requirements of all related sections in the latest C.E.C. Section 10 and the local Electrical Inspection Branch.
- .2 The system to consist of cables, ground rods, supports, and all necessary materials and inter-connections to provide a complete system. Measured resistance to ground of the network shall not exceed 5 ohms.
- .3 All ground conductors shall be run in conduit.

2. Products

- .1 Cables 3/0 and smaller to be connected to ground bars via Burndy Quiklug Type QA-2B connectors. Connections for cables larger than 3/0 shall be brazed.
- .2 All ground wires to be stranded copper R-90 complete with a green jacket unless otherwise shown.
- .3 Ground Grid:
 - .1 Ground rods shall be 20 mm x 3650 mm copper flashed or galvanized for first 400 mm.
 - .2 No 3/0 AWG bare copper interconnected conductors.
 - .3 No 3/0 bare copper to main electrical room ground bus.
- .4 Cable to pipe connectors to be made with Burndy GAR connectors.
- .5 In the main electrical room, provide a copper ground bar complete with lugs suitable to terminate all ground cables. See grounding detail on drawing.
- .6 Utility Padmount Transformers Grounding: Provide ground grid in accordance with utility requirements. Confirm supply of transformer grounding with Utility.

3. Execution

3.1 GROUNDING - GENERAL

- .1 All frames and metallic enclosures of all electrical equipment and electrically operated equipment shall be grounded through the conduit system or via a ground wire.
- .2 All transformers, switchgear, motor control centres, panelboards and splitters fed from the main distribution centre shall be grounded by grounding conductors sized in accordance with the C.E.C. The ground wire shall be terminated at each end with an appropriate grounding lug which shall be connected to the equipment ground bus. Ground wire to be green R-90.
- .3 All sub panels such as lighting panels, local distribution panels, etc., shall be grounded with a green ground wire run back to the panel from which it is fed. The ground conductor shall be sized according to the C.E.C.

-
- .4 All main distribution centres, motor control centres, switchgear, and all panels requiring equipment grounds shall contain a ground bus of adequate size, and tapped for lugs for the ground wire required.
 - .5 All bolted connections must be accessible.
 - .6 All motors shall be grounded by means of an adequately sized green ground wire contained within the feeder conduit.
 - .7 Include a separate green ground wire in all power conduits including branch circuit wiring sized to Table 16, C.E.C.
 - .8 Expansion joints and telescoping sections of raceways shall be bonded using jumper cables as per C.E.C.
 - .9 Use Burndy compression connectors or approved equal for all grounding splices and terminations unless otherwise shown on the Drawings. For bolted ground connections use Burndy Engineering Company's "Durium" or approved equal hardware.
 - .10 Connect all transformer neutrals to the main building ground wire, using compression terminations.
 - .11 Install rigid conduit sleeves where ground wires pass through concrete slabs.
 - .12 Conduit installed buried in earth or installed in or under grade floor slabs shall have separate ground wire installed, whether the conduits are metal or not.
 - .13 Ground all utility services to the electrical system ground.
 - .14 Provide ground wires for main telephone/computer rooms as required and shown on drawings.
 - .15 Provide #6 AWG bonding conductor in all cable tray bond at each section and as per inspection authority requirements. Ground to main electrical system ground.
 - .16 Bond all conduits supplying cabling for systems that uses the cable tray.
 - .17 Sound, Fire, and other communications cabinets minimum #12 to each panel or cabinet location.

END OF SECTION

1. General**1.1 WORK INCLUDED**

- .1 Supply and install all hangers, supports and inserts for the installation shown on the drawings and specified herein, as necessary to fasten electrical equipment securely to the building structure.

2. Products**2.1 FRAMING AND SUPPORT SYSTEM**

- .1 Materials:
 - .1 Intermediate duty supporting structures shall employ P1000 Unistrut or equal together with the manufactures connecting components and fasteners for a complete system.
 - .2 Heavy duty supporting structures to be fabricated and welded from steel structural members and prime painted before installation.
 - .3 Finishes:
 - .1 Outdoors, wet locations: Hot dipped galvanized.
 - .2 Indoors, dry locations: Galvanized when available, prime painted if not available.
 - .3 Nuts, bolts, machine screws: Cadmium plated.
 - .4 Unistrut:
 - .1 Section P1000 or as required for load and span, with mounting screws, or approved. P1000 or equal is a minimum standard for supporting conduits 50 mm and larger.

2.2 CONCRETE AND MASONRY ANCHORS

- .1 Materials: Hardened steel inserts, zinc plated for corrosion resistance. All anchor bolts must be galvanized.
- .2 Components: non-drilling anchors for use in predrilled holes, sized to safely support the applied load with a minimum safety factor of four.
- .3 Manufacturer: Hilti (Canada) Limited or approved equal.

2.3 NON-METALLIC ANCHORS

- .1 Material: Plastic anchors for sheet metal screws.
- .2 Manufacturer: Fischer

2.4 CONDUIT SUPPORTS

- .1 General: Malleable iron one-hole conduit straps where exposed to weather or indoors for conduit smaller than 50 mm. Stamped steel two-hole straps indoors for conduits 50 mm and larger.

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- .2 Structural Steel: Crouse-Hinds "Wedgetite" supports or equivalent manufactured by Appleton.
 - .3 Masonry, concrete, stone, etc: Lead Anchors.
 - .4 Title: Toggle bolts.
 - .5 Metal studs, ceiling hangers, etc.: "Caddy-Clips".
 - .6 Unistrut: Unistrut conduit clamps.
 - .7 Non-metallic not allowed

2.5 CABLE SUPPORTS AND CLAMPS

- .1 General: As per conduit supports, except that for single conductor cables, suitable non-ferrous, or approved stainless steel or aluminum clamps shall be used.

3. Execution

3.1 GENERAL

- .1 Support outlet boxes, junction boxes, panel tubs, etc., independent of conduits running to them. Support conduits within 600 mm of outlet boxes. Support surface mounted panel tubs with a minimum of four 6 mm fasteners.
- .2 Do not cut or drill beams, joists or structural steel unless written permission of the A/E is obtained.
- .3 Distance between conduit or cable supports not to exceed code requirements.
- .4 Supports to be suitable for the real loads imposed by equipment.
- .5 Supports to be securely fastened, free from vibration and excessive deflection or rotation. Maximum deflections are 4 mm over a 1 meter span and 8 mm over a 2 meter span.
- .6 Use metal anchors for all other loads.
- .7 Shot driven pins may only be used with written approval of the structural engineer.
- .8 Use round or pan head screws for fastening straps, boxes, etc.
- .9 Do not support heavy loads from the bottom chord of open web steel joists.
- .10 Install channels in telephone/communication rooms.
- .11 Rack multiple parallel conduit runs on Unistrut support system. Maintain recommended separation between conduits of different systems, e.g. power and low voltage systems.
- .12 Nylon anchors may not be used.
- .13 Fasten exposed conduit to building structure using straps or to exposed beams using beam clamps.

- .14 Suspended support system: Support individual suspended conduits with 6 mm threaded rod and spring clips. Support two or more conduits with on channels supported by min 6 mm threaded rod where direct fastened to building construction id impractical.

END OF SECTION

1. General**1.1 WORK INCLUDED**

- .1 Provide a complete system of boxes for the installation of wiring and equipment.

2. Products**2.1 OUTLET BOXES FOR METAL CONDUIT**

- .1 Materials:
 - .1 Surface or recessed concealed type: Die formed steel, hot dip galvanized, 1.25 oz/sq. ft. minimum zinc coating.
 - .2 Surface mounting exposed: Cast ferrous for threaded conduit, with attached lugs, corrosion resistant two coats finish.
 - .3 Iberville or approved equal.
- .2 Components:
 - .1 Ceiling outlets, surface mounting, concealed:
 - .2 101 mm square, depth 54 mm, Iberville 52171 series
 - .3 119 mm square, depth 54 mm, Iberville 72171 series
 - .4 Ceiling outlets, concealed mounting in concrete:
 - .5 101 mm octagonal concrete rings, depth from 38 mm to 152 mm Iberville 54521 series.
 - .6 Extension ring to change from recessed conduit to exposed conduit, 101 mm octagonal, 38 mm deep square Iberville (type for all) 53151-1/2 or 38 mm deep octagonal Iberville 51151C or 54 mm deep, Iberville (type for all) 55171C.
 - .7 Wall boxes, concealed in concrete or masonry: for one and two gang applications shall be 101 mm square, 54 mm deep, 52171 series complete with suitable 52-C-49 series square cornered raised tile wall cover for proper device and wall surface application. Masonry boxes may be used for line voltage switching.
 - .8 Wall outlets, concealed non-masonry construction, with plaster finish: For one or two gangs used with switches, receptacles, etc., use 54 mm deep Iberville 52171 series, with matching plaster covers, depth to suit. Alternately, use 119 mm square boxes, Iberville 72171 series and covers as required. (For more than two gangs use solid boxes Iberville GSB series with GBC series cover, or special boxes as required).
 - .9 Wall outlets, surface, exposed mounting or used for outdoor outlets: One or more gang, Crouse-Hinds FS series or FD series, conduit.
 - .10 Covers: Unless wiring devices and plates are mounted, provide blank, round canopy covers to match boxes.

2.2 OUTLET BOXES FOR RIGID PVC CONDUIT

- .1 Materials:
 - .1 Rigid PVC boxes and fittings: Unplasticized PVC.
- .2 Components:
 - .1 Floor boxes: Round with threaded hubs for threaded female connectors.

2.3 JUNCTION BOXES AND PULL BOXES, WEATHERPROOF

- .1 Materials:
 - .1 Cast steel, Crouse Hinds, WBJ Series.

2.4 JUNCTION AND PULL BOXES, INDOOR DRY LOCATIONS

- .1 Materials:
 - .1 Code gauge sheet steel, welded construction, phosphatized and factory paint finish.
- .2 Components:
 - .1 For flush mounting, covers to overlap box by 25 mm minimum all around with flush head cover retaining screws.
 - .2 Use rolled edges for surface boxes.
- .3 Junction boxes mounted in exterior walls shall be complete with box vapour barriers.

2.5 JUNCTION BOXES, SURFACE POWER OUTLETS

- .1 Materials
 - .1 Cast aluminum.
- .2 Components:
 - .1 Single gang, 1/2" hubs for 120V duplex receptacle equal to Iberville C-143 or Commander Perfect Line T11 type.
 - .2 Double gang, 1/2" hubs for quad (double duplex) receptacles equal to Commander Perfect Line LT11 type.

2.6 JUNCTION BOXES AND PULL BOXES FOR COMMUNICATION SYSTEM

- .1 Refer to Section 27 05 28.

2.7 CABINETS

- .1 Materials
 - .1 Cabinets: Code gauge sheet steel, welded construction, phosphatized and factory paint finish, suitable for field painting.
 - .2 Locks: to match panelboards.
 - .3 Backboards: 20 mm GIS fir plywood, one piece per cabinet, covering entire cabinet interior.
- .2 Components:
 - .1 Type E: With hinged door and return flange overlapping sides, with handle for surface mounting, size as indicated or to suit.
 - .2 Type T: Surface or flush with trim and hinged door, latch and lock and two keys, size as indicated or to suit. Keyed to match panelboard keys.

2.8 COMPUTER OUTLET BOXES

- .1 Recessed 4" square box complete with two gang plaster ring are to be used for all computer outlets shown on drawings. All wall enclosures are to be white and be complete with barrier, standard duplex outlet covers, blank covers or designated covers as shown on details on drawings.

2.9 MASONRY BOXES:

- .1 Electro galvanized steel masonry boxes single and multiple gang for devices flush mounted in exposed block walls.

2.10 CONCRETE BOXES:

- .1 Electro galvanized steel concrete boxes single and multiple gang for devices flush mounted in concrete walls with extension rings and plaster rings as required to suite application.

3. Execution**3.1 INSTALLATION**

- .1 For flush installation s mount outlet box to allow finish wall to come within 6mm of opening.
- .2 Relocate outlet boxes as directed on site at no extra cost or credit provided that change occurs prior to installation and distance does not exceed, 3.0 m.
- .3 Review the drawings and work of other trades and disciplines to determine best location for electrical outlets and equipment that best uses the available space.
- .4 Prior to roughing in outlets with in a space review the architectural drawings, mill work fitments and elevations to determine the outlet locations Review discrepancies with the owner prior to proceeding.
- .5 Do not install outlet boxes back to back but allow min 150 mm horizontal clearance between boxes.
- .6 Mounting height are from finished grade (AFG) of Above Finished Floor (AFF) unless otherwise noted. If mounting height for a device is not shown confirm height before proceeding. Outlet boxes in masonry should line up with mason course.
- .7 Outlet Boxes:
 - .1 Install all outlets flush and surface mounted as required for the installation.
 - .2 Surface mount above suspended ceilings, or in unfinished areas.
 - .3 Adjust position of outlets in finished masonry walls to suit course lines. Coordinate cutting of masonry walls to achieve neat openings for all boxes.
 - .4 Do not distort boxes during installation. If boxes are distorted, replace with new boxes.
 - .5 Use plaster rings to correct depth. Use 30 mm on concrete block.
 - .6 Do not use sectional boxes.
 - .7 Provide boxes sized as required by the C.E.C.
 - .8 Install vapour barrier material to surround and seal all outlet boxes located on exterior walls of building. Maintain wall insulation.
 - .9 Outlets installed in party walls to be offset by a minimum of one stud space.

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- .10 Ceiling outlet boxes shall be provided for every surface mounted fixture or row of fixtures installed on suspended "hard" ceilings.
 - .11 Support outlet boxes independently of supporting conduit.
 - .12 Fill boxes with paper, foam to prevent entry of foreign material. Remove upon completion of work.
- .8 Junction Boxes and Pull Boxes:
- .1 Supply all pull boxes and junction boxes shown on the drawings or required for with system name and circuit designation as applicable.
 - .2 Size in accordance with the Canadian Electrical Code, as a minimum.
 - .3 support independently of supporting conduit.
- .9 Cabinets:
- .1 Mount cabinets with top not greater than 1980 mm above finished floor, coordinated with masonry, panelboards, fire hose cabinets and similar items. Securely fasten backboards to cabinet interiors.

END OF SECTION

1. General

1.1 WORK INCLUDED

- .1 Provide a complete system of conduit and fittings for installation of wiring.
- .2 Contractor may install sub-distribution conduit for panel feeders in slab on grade. No panel feeder conduit is to be run in structural slabs. All other conduit work is to be done above ground in ceiling space.

2. Products

2.1 RIGID STEEL CONDUIT

- .1 Galvanized with threaded joints and connections.
- .2 Connections in dry locations: steel or malleable iron locknuts outside enclosures. Insulated bushings Thomas & Betts Type 222 or approved alternate.
- .3 Connectors subjected to moisture interior and exterior: liquid and dust tight with insulated throat, Thomas & Betts "Bullet Hub" 370 Series.
- .4 Fittings: cast metal "Condulet" as manufactured by Crouse-Hinds Canada Ltd. including gasketed covers in damp locations.
- .5 Expansion joints: cast metal Crouse-Hinds type XJ or approved alternate.

2.2 E.M.T. CONDUIT

- .1 Fittings in dry locations: steel set-screw type, coupling and connectors with insulated throats or non-metallic bushings, Thomas & Betts Ltd. Series 5031.

2.3 RIGID P.V.C. CONDUIT

- .1 Conduit: rigid non-metallic conduit of unplasticized polyvinyl chloride C.G.E. "Sceptre" Schedule 40.
- .2 Fittings: threaded male or female solvent weld connectors and solvent weld couplings, as supplied by conduit manufacturer.
- .3 Solvent: as recommended by conduit manufacturer.

2.4 FLEXIBLE CONDUIT

- .1 Connectors: slip-proof, insulated throat or non-metallic bushings, steel, Thomas & Betts Ltd. "Tite-Bite", Series 300.

2.5 LIQUID -TIGHT FLEXIBLE CONDUIT

- .1 Conduit: flexible metal conduit with liquid-tight PVC jacket. Industrial Wire & Cable "Liquidseal".
- .2 Connectors: captive sealing jacket and ground cone insulated throat, steel (Thomas & Betts Ltd. "Super-Tight", Series 6000). Liquid tite connectors for liquid tight conduit.

3. Execution

3.1 RIGID STEEL CONDUIT

- .1 Use as raceways for following applications:
 - .1 In all areas exposed to weather.
 - .2 Locations where mechanical damage may occur and in mechanical rooms to a height of 1 metre.

3.2 E.M.T. CONDUIT

- .1 Use as raceways for following applications:
 - .1 In surface and concealed areas or in poured concrete above ground level.
- .2 It may not be used in damp locations, corrosive atmosphere, underground, outdoors, nor in areas exposed to mechanical damage.

3.3 RIGID P.V.C. CONDUIT

- .1 Use as raceways for following applications:
 - .1 In poured concrete floors and walls and on underground runs exterior to the buildings unless otherwise noted.
 - .2 Wiring installed in areas subject to intermittent or continuous moisture but not surface mounted.
 - .3 Rigid PVC conduit shall not be surface mounted.
- .2 Use strictly in accordance with the C.E.C. Do not use in return air plenums and for exit and fire escape lights.
- .3 Provide insulated ground wire in all rigid PVC conduits in accordance with the C.E.C.
- .4 Where rigid PVC conduit is set in poured concrete, solvent joints must be completed and allowed to set as per manufacturer's instructions.
- .5 Bend rigid conduit in strict accordance with manufacturer's directions. Distorted bends will not be accepted.

3.4 FLEXIBLE CONDUIT AND BX

- .1 Use as raceways for following applications:
 - .1 Flexible connections to luminaires and ceiling mounted devices in suspended ceilings and T-bar.
 - .2 Armoured cable "BX" connections to recessed and/or hanging luminaires. (BX shall not be used to loop between fixtures.)
 - .3 Maximum length of BX to be 1.5 meters from Junction Box.
- .2 Provide a separate insulated ground wire in all flexible conduits.
- .3 Within new drywall partitions to interconnect electrical devices on the same wall, except that the connection from the junction box above the suspended ceiling down to the first electrical device in the drywall shall be wired in EMT conduit.

3.5 RIGID PVC DUCT

- .1 Provide a separate green insulated copper ground wire in all ducts as required by the Code.
- .2 Arrange ducts in a horizontal layer separated by plastic spacers to provide spacing between duct centres, as shown on the drawings.
- .3 Support duct bank on plastic spacers 35 mm between ducts. Foundation spacers to maintain at least 76 mm clearance between ducts and exterior coverage.
- .4 Make joints with tapered couplings to provide a secure watertight connection. Stagger all joints to provide 200 mm vertical and horizontal clearance between adjacent couplings. Where needed, use factory bends to provide bends of radius required.
- .5 When all ducts are installed, brace whole assembly at each spacer group to prevent duct floating when concrete is placed.
- .6 Terminate ducts with standard bell ends where ducts enter cable pits, junction boxes and building interiors.
- .7 Cap ends of unused ducts with plug ends of same material as ducts.
- .8 Seal all joints in ducts with solvent cement.

3.6 LIQUID -TIGHT FLEXIBLE CONDUIT

- .1 Use as raceways for following applications:
 - .1 At all motors, transformers, pipe mounted control devices, and other devices subject to movement or water.
 - .2 At all CTS equipment and kitchen equipment.
- .2 At all motors provide a short length before connecting to the motor terminal box. Minimum length shall be 450 mm plus 4 times the conduit diameter.
- .3 Provide a separate ground wire within flexible conduit, bonded to motor frames and system ground.
- .4 Liquid tight connections required on all liquid tight flex.

3.7 WORKMANSHIP

- .1 Install all conduit and wiring concealed, unless otherwise shown on the drawings. Do not recess conduit in columns, except as noted, without permission.
- .2 Where conduit is run exposed, run parallel to building lines. Where conduits are grouped (two or more), space evenly, make bends concentric and mount on Unistrut racks.
- .3 Lay out conduit to avoid interference with other work. Maintain a minimum clearance of 150 mm from steam or hot water piping, vents, etc.
- .4 Slabs on grade: Install rigid PVC conduit in the gravel base below concrete slabs. Provide mechanical protection around stub-ups through slab and extend 150 mm beyond concrete. When rigid steel conduit is installed in contact with earth it shall be protected by Polykin #940 tape. Extend taping 300 mm above finished grade.

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- .5 Metal conduit installations in concrete pours: Tie down conduit to prevent shifting. All joints are to be made up tight to ensure ground continuity. To prevent concrete entry, seal EMT set screw fittings with tape, pack outlet boxes and cap conduit terminations both in boxes and stub-ups. Apply Polykin #940 tape to the conduit 152 mm both sides of the point of leaving slab.
 - .6 Do not place conduit in concrete slabs in which slab thickness is less than four times conduit diameter. Place conduits larger than this size under floor. Conduits to have minimum 25 mm concrete cover.
 - .7 Organize conduit in slabs to minimize crossovers. Obtain approval and minimum concrete cover required from structural engineer prior to installing conduits in slabs.
 - .8 At all recessed panels cap 2 - 25 mm and 4 - 19 mm empty conduits from panel into ceiling above and below for future use.
 - .9 Provide Brady underground warning tapes 300 mm below grade above all underground conduits. Tape shall be red, 150 mm wide, catalogue no. 91296.
 - .10 Where conduits or ducts enter or exit concrete structures below grade provide 16 mm x 1500 mm steel reinforcing dowels to prevent shearing. Extend dowel 1000 mm beyond concrete and band conduit to dowel. The first 3 meter length of conduit extending from the structure to be Polykin wrapped rigid steel.
 - .11 Where conduit is installed in floor slabs to run up at equipment or motors, carefully check all conduit locations. Verify conduit locations for mechanical equipment from shop drawings or detail drawings. Brace all stub-ups. Stub-ups shall be rigid steel.
 - .12 Where steel conduit is required to be bent, do not heat, and do not bend conduit in such a way as to reduce pipe cross section area at any point. Radii of bends shall be as per C.E.C.
 - .13 For all runs of conduits, do not include more than equivalent of 4 - quarter bends. Provide conduit fittings, pullboxes and junction boxes where necessary. Pulling elbows shall not be used except by special permission.
 - .14 Where possible, install conduits so that they are not trapped, cap turned up conduits to prevent the entrance of dirt or moisture during construction. Swab out conduit and thoroughly clean internally before wires and cables are pulled.
 - .15 Take extreme care in reaming ends of all conduit to ensure a smooth interior finish that will not damage the insulation of the wires.
 - .16 Use insulated non-metallic bushings on all conduit terminations.
 - .17 Ensure electrical continuity in all conduit systems.
 - .18 All conduit shown exposed in finished areas is to be free of labels and trade marks.
 - .19 Install a 90 lb. test line in all conduits left empty by this contractor including those which others will pull cables, wires, etc.
 - .20 Conduits and ducts crossing building expansion joints shall have conduit expansion fittings to suit the type of conduit used, and shall be Crouse-Hinds, Sceptre, or FRE.

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- .21 Seal conduits with duct seal where conduits are run between heated and unheated areas. Where conduits, cables, or cable trays pierce fire separations, seal openings with Dow Corning 3-6548 sealant.
 - .22 Where conduits pass through walls, they shall be grouped and installed through openings. After all conduits shown on the drawings are installed, wall openings shall be closed with material compatible with the wall construction. Review size and quantity of conduit sleeves with the Departmental Representative.
 - .23 Where drawings show conduit designations, these conduits shall be identified at each point of termination with Thomas & Betts "Ty-Rap" No. TY532M labels.
 - .24 Where conduit finish is damaged, repair or replace.
 - .25 Use "Condulet" fittings for power and telephone type conduit terminations in lieu of boxes where support is not provided.
 - .26 All branch circuit wiring, home-runs, communication and data to be minimum 20 mm diameter.
 - .27 Provide necessary flashing and pitch pockets, making watertight joints where conduits pass through roof or watertight membranes.
 - .28 Where panelboard branch circuit conduits are amalgamated, size shall not exceed 25 mm diameter.
 - .29 Conduit shall not impede service access to mechanical and electrical equipment. I.e. VAV or filter access on HVAC units.

3.8 CONDUIT IN SLAB

- .1 All conduit with the exception of main shall be installed above finished floor level and shall not be installed in floor slab or underground and are not to penetrate attic space except where specifically indicated.

3.9 CONDUIT UNDER STRUCTURAL SLABS

- .1 All conduits installed below structural slabs are to hung with a minimum 6.3 mm threaded rod and approved conduit clamps at intervals as required by the CEC. Contractor is to examine structural drawings to determine extent of the structural slab.

3.10 CONDUIT BENDS

- .1 For communications conduit system a maximum of 180° bend is permitted between pull boxes. Refer to Section 27 05 28 for additional information.

END OF SECTION

1. General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA)
- .1 CAN/CSA C22.2 No. 126-2009, Cable Tray Systems

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 00 10 – Shop Drawings, Product Data, Samples and Mock-ups.
- .2 Identify types of cable tray used.
- .3 Show actual cable tray installation details and suspension system.

2. Products

2.1 CABLE TRAY

- .1 Cable tray and fittings: to CAN/CSA C22.1.
- .2 Continuous, rigid, welded steel wire mesh cable management system.
- .3 Trays: galvanized steel mesh system, welded at all intersections with safety edge T-welded wire lip. Carbon steel wire 4.5mm dia, to ASTM A510 grade 1008.
- .4 Fittings: use only manufacturer recommended fittings.
- .5 Only low voltage systems are to be installed in the cable tray.
- .6 Approved manufacturers are Thomas & Betts Express Tray, Cablofil EZ Tray and Cope Cat-Tray

2.2 SUPPORTS

- .1 Provide supports as required and recommended by the manufacturer at a minimum of 1500mm apart and 600mm from ends.

3. Execution

3.1 INSTALLATION

- .1 Install complete cable tray system.
- .2 Support cable tray on both sides.
- .3 Remove sharp burrs or projections to prevent damage to cables or injury to personnel.
- .4 Bond all sections of the cable tray system to the main communication ground bar using a #6 AWG copper wire.
- .5 Dimensions: Mesh – 50x100mm nominal, straight section lengths – 3 meters, cable tray width 300mm, cable trays depth to be 100mm.

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- .6 Communication conduits installed to within 400 mm of cable tray and are longer than 7.5m (from outlet to tray) are to be bonded to the cable tray.

3.2 CABLES IN CABLE TRAY

- .1 Install cables individually.
- .2 Lay cables into cable tray. Use rollers when necessary to pull cables.
- .3 Secure cables in cable tray at 6m centres, with milk-tie wraps.
- .4 Identify cables every 30m with size 2 nameplates in accordance with Section 16040.
- .5 Lighting or power cables shall not be installed in the cable tray.
- .6 Cable tray fill shall not exceed forty percent (40%).

3.3 FIRE BARRIERS

- .1 Cable tray to run to within 450mm of Fire Rated Walls. Conduits (minimum 6-53mm conduits) to run between cable trays on either side of fire rated walls. Provide fire stopping at wall penetrations. Arrange and make good-fire rating of walls after conduits have been installed.
- .2 Or run cable tray to within 100 mm of wall and install fire rated cable pass through for full capacity of the tray. As STI EZ -Path series 33 pass through.

END OF SECTION

1. General**1.1. SCOPE**

- .1 The work under this section includes underground cast-in-place concrete ductbanks for electrical power and signal system distribution. The term "signal" is used thorough this specification as a generic term to include communications, control, security and other low voltage systems. Included are the following topics:

1.2. RELATED WORK

- .1 Applicable provisions of Division 1 govern work under this Section
- .2 Section 26 05 44 – Manholes
- .3 Section 26 08 00 - Commissioning of Electrical
- .4 Section 01 91 01 or 01 91 02 – Commissioning Process

1.3. SUBMITTALS

- .1 Indicate material specifications, and provide product data on conduit, spacers, terminators, reinforcing steel and related components.

2. Products**2.1. CONDUIT**

- .1 Size: 5" nominal for voltages above 600V, and 4" nominal for 600V or lower and communication system applications.
- .2 Material: Rigid polyvinyl chloride (PVC) marked at uniform intervals to indicate the kind of material; type Schedule 40 heavy wall, type EB-20 (TC-6), or type EB-35 (TC-8). Type EB conduit is rated for use only in concrete encased applications.

2.2. ELBOWS

- .1 Material to match conduit; minimum bend radius of 36 inches (915 mm).

2.3. SPACERS

- .1 Plastic, to maintain 3" minimum between conduits.

2.4. CONDUIT TERMINATION IN MANHOLES AND BUILDINGS

- .1 Bell Ends: Manufactured bell ends of appropriate sizes at each end of conduit. When entering a new building or a new manhole a pre-manufactured PVC bell end system (as manufactured by Formex or similar) with conduit seals, provisions for roughing into the concrete and water stops is allowed.
- .2 Seals: When entering an existing building or manhole below grade, the concrete shall be core drilled for the appropriate size conduit and seal. The seal shall be a mechanical interlocking assembly of modular rubber links properly sized to fit the pipe and tightened in place, in accordance with the manufacturer's instruction.
- .3 Bushings: Steel grounding bushings shall be used on all metal conduits entering a building or manhole.

2.5. PLUGS

- .1 Expandable pipe plug, gas and water tight, for sealing empty conduit. Plug shall be high impact plastic with an outer rubber gasket expandable by hand tightening a wing nut on a central spindle.
- .2

2.6. PULL TAPE

- .1 Polyester pull tape, 1/2" width, tensile strength of 1,250 lbs. with sequential footage markings along the entire length of the tape as manufactured by Greenlee, Carlon, Garvin Industries, or Neptco (Muletape). Install pull tape in each empty conduit.

2.7. GROUNDING

- .1 Steel grounding bushings shall be grounded to manhole or junction box ground.

2.8. DRAINAGE ASSEMBLY

- .1 All ducts shall drain to an open end - preferably a manhole.

2.9. CONCRETE ENCASEMENT

- .1 Concrete used throughout shall be ready mixed concrete furnished by an approved mixing plant. The plant shall comply with the requirements of National Ready Mixed Concrete Association certification plan.
- .2 The concrete mix used with type Schedule 40 heavy wall conduit shall be 3000 psi minimum, 3/4" aggregate.
- .3 The concrete mix used with type EB-20 (TC-6), or type EB-35 (TC-8) thin wall conduit shall be 2500 psi minimum, 3/8" pea gravel aggregate.
- .4 The slump shall be just enough to allow the mix to flow to the bottom of the formation and yet not be so wet as to cause the ducts to float.
- .5 Encase duct with 3 in. minimum of concrete on top, bottom, and sides with top of duct bank troweled to a smooth crown to prevent pooling of water.

2.10. REINFORCING STEEL

- .1 Provide reinforcing steel the entire length of the duct system, four - #4 bars - one in each corner, minimum, or as shown on the drawings. Tie or dowel the reinforcement steel into the connecting walls of manholes, vaults and buildings, etc. to protect against vertical shearing.

2.11. UNDERGROUND WARNING TAPE

- .1 Detectable underground warning tape, 2" wide minimum, 5 mil thickness, containing a foil core as manufactured by Presco, Seton, or similar.
- .2 Tape color and labeling shall be as follows:
 - .1 Electrical Power Systems: Red color and labeled with the words "CAUTION-BURIED ELECTRIC LINE BELOW" or similar.
 - .2 Communication Systems: Orange color and labeled with the words "CAUTION-BURIED COMMUNICATION LINE BELOW" or similar.

3. Execution**3.1. EXCAVATIONS**

- .1 Excavate trenches for ductbank to adequate width, depth, and proper slope as specified.
- .2 Install forms on sides of ductbank if trench is not of proper firmness to prevent cave-in.
- .3 The trench sidewall shall be less than 6 inches from the edge of the conduit being installed. Install forms if needed to limit the trench width.

- .4 Bottom of trench shall be undisturbed earth. If trench bottom is too low for proper grade, fill to proper level with sand and mechanically compact it.
- .5 Each excavated section from manhole to manhole and from manhole to building shall be completely excavated and graded before any duct is laid in that section.

3.2. PLACEMENT OF CONDUIT

- .1 Install flush bell ends on duct at manholes and buildings. When entering a new building or a new manhole, a pre-manufacture end bell system (by Formex or similar) with conduit seals is allowed.
- .2 When entering an existing building or manhole, core drill existing walls and waterproof using a mechanical seal of assembled rubber links properly sized for the pipe and tighten in place, in accordance with the manufacturer's instruction, after the new conduit is installed.
- .3 Install spacers as recommended by conduit manufacturer and requirements stated above, but not to exceed a maximum of 6 ft-0 in. on center for PVC conduit and 8 ft-0 in. on center for steel conduit. Bottom spacers shall rest on 8" X 16" X 2" concrete pads to prevent them from sinking into the ground and reducing the bottom concrete cover. Stagger conduit joints in concrete encasement 6 in. minimum horizontally.
- .4 Tie the conduit assembly down at regular intervals so it does float up in the concrete during the pour.
- .5 Pitch conduit properly for drainage to manhole and to prevent low pockets or irregular dips between conduit ends. Pitch conduit away from building and toward manhole. Minimum pitch to be 4 inches per 100 feet.
- .6 Install not more than one 90 degree bend or equivalent between manholes for primary conduit and two 90 degree bends or equivalent for signal conduit.
- .7 In ductbanks with both primary and signal conduit, primary conduit shall be straight and the signal conduit shall contain bends as necessary to accommodate the primary duct.
- .8 Install insulated grounding bushings on steel duct ends.
- .9 Install closure plugs in all empty conduits at manhole and building entrances and at terminations in equipment pedestals to prevent the entrance of water, sediment and vapors.

3.3. PLACEMENT OF REINFORCING BARS

- .1 At new building and manhole walls, tie duct bank and wall reinforcing steel together to provide a permanent connection.
- .2 At existing building and manhole walls, dowel reinforcement bar into the wall to provide protection against vertical shearing. Use epoxy adhesive to secure the dowels.
- .3 Install the bars - one in each corner, minimum or as shown on the drawings, overlap the joints 12" and tie into the connecting walls of manholes, vaults, and buildings, etc.

3.4. PLACEMENT OF CONCRETE

- .1 After ducts are in place and before the concrete is poured, the installation shall be inspected by the DFD Construction Representative. Notify the Construction Representative at least two days before the time of inspection.
- .2 The Contractor shall supervise the placement of concrete in the ductbank.
- .3 Complete entire section of conduit from manhole to manhole or from manhole to building before encasement by concrete.
- .4 Top of concrete envelopes shall be not less than 24 inches below grade.

- .5 In placing concrete around the conduit, adjust delivery chute so the fall of the concrete into the trench is minimal.
- .6 Vibrating is not allowed as it tends to cause the conduit to float up in the concrete.
- .7 Provide minimum of 3" (76 mm) of concrete cover over conduit at the top, bottom and sides with top of duct bank troweled to a smooth crown to prevent pooling of water.
- .8 Place concrete continuously from manhole to manhole to building without interruption.
- .9 Extend concrete envelope to finish floor grade or interior wall surface in buildings and finish pad grade at equipment. Maintain moisture seal.

3.5. BACKFILL

- .1 Compact backfill around ductbank.
- .2 Install warning tape 12" below finish grade over all ductbanks. For ductbanks more than 24" wide, install multiple runs of warning tape no farther than 18" apart. The warning tape shall not be farther than 12" from the ductbank edge.

3.6. RESTORATION

- .1 After completion of ductbank installation, return all ground and pavement surfaces to original condition or to condition as indicated on the drawings. This includes all sidewalks, curbs, streets, parking areas, lawns, plantings, etc.

3.7. ACCESSORY INSTALLATION

- .1 Pull a mandrel/swab (diameter 1/4 in. smaller than conduit) through each conduit in completed ductbank to insure adequate opening of duct run.
- .2 Install pull tape with measurement markings in each empty duct.
- .3 Install closure plugs in all empty conduits at manhole and building entrances and at terminations in equipment pedestals to prevent the entrance of water, sediment and vapors.
- .4 Ground all steel bushings to manhole or junction box ground.

3.8. CONSTRUCTION VERIFICATION

- .1 Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 26 08 00 in accordance with the procedures defined for construction verification in Section 01 91 01 or 01 91 02.

END OF SECTION

1. General**1.1 RELATED REQUIREMENTS**

- .1 Electrical General Requirements Section 26 05 01

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS

- .1 Conduit Section 26 05 33

2. Products**2.1 COMPONENTS**

- .1 Conduit: Type Rigid PVC Duct, DB2 otherwise.
- .2 Concrete: 20 MPa with additive to give permanent red colour - 20 mm maximum aggregate size.
- .3 Markers: Markers shall be square with 25 mm letters.
- .4 Conductors: Refer to Section 26 05 19
- .5 Cable Lugs: Suitable for the application and use as required by the Canadian Electrical Code, approved by the electrical inspection authority and acceptable to the local supply authority.

3. Execution**3.1 INSTALLATION**

- .1 Installation shall be on undisturbed soil or on well compacted granular fill, 150mm thick.
- .2 Install at minimum of 1 meter below finished grade.
- .3 Install rigid PVC conduit in configuration indicated. Spacers installed at maximum intervals of 1.5 meters.
- .4 Clean conduits before laying. Cap ends during construction and after installation to prevent entrance of foreign materials.
- .5 Route of conduit runs shall be marked with marking tape, Brady Identoline, laid in trench approximately 300mm below grade.
- .6 Check all conduits for clear bore before backfilling. Install fish wires in all conduits.
- .7 Coordinate routing and depth of all conduits with General Contractor.
- .8 Conduits shall be encased in concrete where run below parking or vehicle traffic areas.

3.2 DUCT BANK INSTALLATION

- .1 Provide reinforcing rods and band ties over entire length as detailed.
- .2 Ensure that concrete fills all voids around ducts.

- .3 Lay PVC ducts with configuration and reinforcing as indicated with preformed interlocking, rigid plastic intermediate spacers to maintain spacing between ducts at not less than 40 mm horizontally and vertically. Stagger joints in adjacent layers at least 150 mm and make joints watertight. Encase duct bank with minimum 75 mm thick concrete cover on all sides.
- .4 Slope ductbanks 150 mm per 30 m minimum to drainage point. Adjust final slopes on site to coordinate with existing utilities. Slope away from building.
- .5 Provide drain holes not less than 12 mm in diameter in each conduit and provide a fabricated 50 mm drain assembly with saddle cutouts for each conduit fitting over the drain line. Tape drain assembly to each conduit to prevent entrance of concrete. Band drain assembly with 12 mm stainless steel straps to conduit assembly to prevent mechanical displacement.
- .6 Install on undisturbed soil where possible. Backfill required to be compacted pit run gravel and sand, 200 mm lifts maximum.
- .7 Clean and swab all ducts. Install galvanized iron pullwires in spare ducts. Cap spare ducts.

3.3 SERVICE INSTALLATION

- .1 General routing to follow that indicated on drawings.
- .2 Contractor to provide required trenching backfill etc. to install primary & secondary feeders, Telus, Cable TV and Supernet underground in coming conduits. Coordinate with Utility.

END OF SECTION

1. General

1.1 SUMMARY

- .1 All electrical fittings, supports, hanger rods, pull boxes, channel frames, conduit racks, outlet boxes, brackets, clamps, etc. to have galvanized finish or enamel paint finish over corrosion-resistant primer.
- .2 All panelboards, distribution centres, motor control centres, transformers, etc. to be factory finished in alkyd high gloss enamel applied over corrosion-resistant primer. Matte or flat type finish paint not acceptable. Factory finished units that are scratched or marked during installation or shipping to be touched up with matching spray-on air dry lacquer or, if required to provide a satisfactory job, completely refinished.
- .3 All panelboards, distribution centres, transformers, motor control centres, low voltage cabinets, pull boxes and raceways to be colour coded as follows. The exact colour to be approved by the architect prior to manufacture.
- .4 All 120/208 volt equipment including pull boxes and raceways to be finished in grey.
- .5 Transformer enclosures to be finished in accordance with primary voltage colour as outlined above.
- .6 Low voltage switching terminal cabinets and pull boxes to be finished in black.
- .7 Telephone terminal panels and junction boxes to be finished in green.
- .8 Public address terminal panels and junction boxes to be finished in yellow.
- .9 Security terminal panels and junction boxes to be finished in orange.
- .10 R.F. television and satellite system pull boxes and junction boxes to be finished in ivory.

1.2 NAMEPLATES

- .1 Clearly identify all major electrical equipment including main distribution centres, sub-distribution panels, power panels, lighting panels, disconnect switches, starters, contactors, motor control centres, terminal cabinets and panels, pushbuttons and selector switches, etc. by permanent labels described below.
- .2 Provide nameplates of lamicoid plastic with black back showing 10 mm white letters mounted in conspicuous location on the surfaces of the equipment, except in finished areas locate nameplates in flush panels mounted on panel front inside enclosure.
- .3 Nameplates to be black/white/black giving white letters on black background for all normal power equipment. Nameplates to be red/white/red giving white letters on red background for all emergency power equipment.
- .4 All nameplates to include equipment name and designation number as shown on drawings, and voltage rating. All nametags to be attached to the outside of panel doors and equipment enclosures.

-
- .5 In terminal cabinets for control wiring, low voltage relays, intercommunication, telephone, clock, etc. Identify terminal strips, etc. utilizing 9.5 millimetre roll adhesive back embossed type nametags.
 - .6 Transformers: identify as shown on drawings showing capacity and primary and secondary voltages.
 - .7 Disconnect switches, starters and contactors indicate equipment being controlled and voltage.
 - .8 Terminal cabinets and pull boxes: indicate system and voltage.
 - .9 On/Off switches: indicate equipment being served.
 - .10 Distribution centres: identify distribution centres as indicated on drawings and main voltage or voltages if more than one.
 - .11 Motor control centres: identify as shown on drawings and show main voltage or voltages if more than one.
 - .12 Surface raceway normal and emergency receptacles: identify panel and circuit number.
 - .13 All receptacles: identify panel and circuit number. Special receptacles to be identified by architect. Confirm identification method with PCA Departmental Representative.
 - .14 Receptacles and light switches: use Kroy label showing panel and circuit numbers.
 - .15 Ceiling mounted junction boxes: use permanent marker showing panel and circuit numbers on junction boxes or on slab beside junction boxes.
 - .16 Emergency lighting remote heads to be with lamacoid with battery pack designation on the base.
 - .17 Battery packs to be labelled with lamacoid with battery pack designation.

1.3 CABLES

- .1 Clearly label all ends of low voltage system cables to conform with EIA/TIA 606 standards. Use wire sleeves equal to Brady LS2000 series. The label shall not be handwritten and shall be affixed to the cable jacket.

END OF SECTION

1. General**1.1. SCOPE**

- .1 The electrical contractor shall retain the services of an independent third party firm, or the equipment manufacturer's technical services group, to perform a short circuit/coordination study and arc flash risk assessment as described herein.
- .2 Preliminary studies shall be submitted to the A/E prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment for manufacture to ensure the characteristics and ratings of the proposed overcurrent devices will be satisfactory. The final submittal shall capture any changes in circuit lengths, wire sizes, Additionalloads, etc. that may occur during the construction project.
- .3 The studies shall include all portions of the electrical distribution system from the normal power source or sources, and emergency/standby sources, down to and including the smallest circuit breaker in the distribution system (for short circuit calculations). Normal system connections and those which result in maximum fault conditions shall be adequately covered in the study.
- .4 The firm should be currently involved in medium- and low-voltage power system evaluation. The study shall be performed, stamped and signed by a registered professional engineer in the State of Wisconsin. Credentials of the individual(s) performing the study and background of the firm shall be submitted to the A/E for approval prior to start of the work.
- .5 The firm performing the study should demonstrate capability and experience to provide assistance during start up as required.
- .6 The study and assessment shall be performed on SKM Dapper, Captor and PowerTool software or EasyPower product suite software.

1.2. RELATED WORK

- .1 Applicable provisions of Division 1 govern work under this section
- .2 Section 26 14 13 – Switchboards
- .3 Section 26 24 16 – Panelboards
- .4 Section 01 91 01 or 01 91 02 – Commissioning Process

1.3. REFERENCE STANDARDS

- .1 Standards listed in the IEEE "Buff Book", latest edition
- .2 National Fire Protection Association (NFPA) 70E, latest Facility
- .3 IEEE 1584 – Guide for Performing Arc Flash Calculations

1.4. DATA COLLECTION FOR THE STUDY

- .1 The contractor shall provide the required data for preparation of the studies. The engineer performing the system studies shall furnish the contractor with a listing of the required data immediately after award of the contract.
- .2 The contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to release of the equipment for manufacture.

1.5. SUBMITTALS

- .1 THIRD PARTY QUALIFICATIONS: Submit qualifications of individual(s) who will perform the work to the A/E for approval prior to commencement of the studies.
- .2 PRELIMINARY REPORT: Submit a draft of the studies to the A/E for review prior to delivery of the final study to the Owner. Make all Facility's or changes as required by the reviewer.
- .3 FINAL STUDY REPORT: Provide studies in conjunction with equipment submittals to verify equipment ratings required.
- .4 The results of the power system studies shall be summarized in a final report and provided in the following formats. Provide (2) bound hard copies of the final report. Provide (2) electronic copies (on CD) of the final report and one-line diagrams in PDF format. Provide (2) electronic copies (on CD) of the final report in MS Word format and the one-line diagrams in CAD format.
- .5 Also provide (2) electronic copies (on CD) of all files generated by the SKM or EasyPower software for all scenarios evaluated in the studies. The files shall permit the studies to be opened, reviewed or updated by any user of the analysis software used for the studies.
- .6 The report shall typically include the following sections:
 - I. Overview
 - II. Short Circuit Study
 - SC-1 Purpose
 - SC-2 Explanation of Data
 - SC-3 Assumptions
 - SC-4 Analysis of Results
 - SC-5 Recommendations
 - SC-6 Fault Analysis Input Report from Software Program
 - SC-7 Fault Contribution Report
 - III. Protective Device Coordination Study
 - PDC-1 Purpose
 - PDC-2 Explanation of Data
 - PDC-3 Assumptions
 - PDC-4 Analysis of Results
 - PDC-5 Recommendations (Including NEC 700-27 Requirement)
 - PDC-6 Results from Software Program
 - PDC-7 Example Drawings
 - IV. Arc Flash Study
 - ARC-1 Purpose
 - ARC-2 Explanation of Data
 - ARC-3 Assumptions
 - ARC-4 Analysis of Results
 - ARC-5 Recommendations
 - ARC-6 Arc Flash Evaluation Report from Software Program
 - V. Prioritized Recommendations and Conclusions
 - VI. Appendices
 - APP-1 One-line Diagrams from Software Program
 - APP-2 AutoCAD One-line Diagrams
 - APP-3 Protective Device Summaries from Software Program
 - APP-4 Reference Data
 - APP-5 Sample Work Permit Form
 - APP-6 Copy of Warning Labels, including study date
- .7 The above sections shall include the following items in detail:
 - Obtain available fault current from the local utility company.
 - Short circuit studies shall evaluate the available fault current at each bus (each change of impedance), including all three-phase motors.

- Coordination study recommendations for relay settings, breaker settings, and motor protection settings.
- Recommendations for improving the coordination and/or load distribution, as well as ground fault requirements.
- Worst case Arc Flash values (highest incident energy) for project specific scenarios (low short circuit and high short circuit for each possible power supply source).
- Arc flash values for two maintenance cases, which define the arc flash values available at the equipment that would be available if the instantaneous trip of the upstream circuit breaker is set at a minimum value. This is recommended if someone has to work on live equipment.
- IEEE standard one-line diagram with equipment evaluation and circuit breaker settings that clearly define the system data and are easy to interpret. The diagrams should include the bus names and references used in the studies.
- Recommendations to reduce the arc flash incident energy in all areas that are subject to 8 calories per square centimeter or greater of available incident energy.
- Condition of Maintenance information for any existing equipment included in the study.
- Prioritized report summarizing all recommendations from this study. This shall include observed NEC code violations and their corrective action.
- The contractor shall provide a one-line diagram that meets IEEE/ANSI standard 141, mounted on 24" x 36" (minimum) Styrofoam backboard. This one-line diagram shall be mounted in each electrical room.

2. Products

2.1. Not used.

3. Execution

3.1. SHORT CIRCUIT AND COORDINATION STUDY

- .1 The short circuit, coordination, and arc flash hazard studies shall be performed using SKM Dapper, Captor and PowerTool for Windows software or EasyPower product suite Windows based software packages. In the short circuit study, provide calculation methods and assumptions, the base per unit quantities selected, one-line diagrams, source impedance data including power company system characteristics, typical calculations, and recommendations. Calculate short circuit interrupting and momentary (when applicable) duties for an assumed 3-phase bolted fault at each supply switchgear lineup, unit substation primary and secondary terminals, low voltage switchgear lineup, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboard, and other significant locations throughout the system. Provide a ground fault current study for the same system areas, including the associated zero sequence impedance data. Include in tabulations fault impedance, X to R ratios, asymmetry factors, motor contribution, short circuit KVA, and symmetrical and asymmetrical fault currents.
- .2 In the protective device coordination study, provide time-current curves graphically indicating the coordination proposed for the system, centered on conventional, full-size, log-log forms. Include with each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered by that particular curve sheet. Include a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Tabulate recommended device tap, time dial, pickup, instantaneous, and time delay settings.

- .3 Include on the curve sheets power company relay and fuse characteristics, system medium-voltage equipment relay and fuse characteristics, low-voltage equipment circuit breaker trip device characteristics, pertinent transformer characteristics, pertinent transformer characteristics, pertinent motor and generator characteristics, and characteristics of other system load protective devices. Include at least all devices down to largest branch circuit and largest feeder circuit breaker in each motor control center, and main breaker in branch panelboards.
- .4 Include all adjustable settings for ground fault protective devices. Include manufacturing tolerance and damage bands in plotted fuse characteristics. Show transformer full load and 150, 400, or 600 percent currents, transformer magnetizing inrush, ANSI transformer withstand parameters, and significant symmetrical and asymmetrical fault currents. Terminate device characteristic curves at a point reflecting the maximum symmetrical or asymmetrical fault current to which the device is exposed.
- .5 Select each primary protective device required for a delta-wye connected transformer so that its characteristic or operating band is within the transformer characteristics, including a point equal to 58 percent of the ANSI withstand point to provide secondary line-to-ground fault protection. Where the primary device characteristic is not within the transformer characteristics, show a transformer damage curve. Separate transformer primary protective device characteristic curves from associated secondary device characteristics by a 16 percent current margin to provide proper coordination and protection in the event of secondary line-to-line faults. Separate medium-voltage relay characteristic curves from curves for other devices by at least a 0.4-second time margin.
- .6 Include complete fault calculations as specified herein for each proposed and ultimate source combination. Note that source combinations may include present and future supply circuits, large motors, or generators as noted on drawing one-lines.
- .7 Utilize equipment load data for the study obtained by the Contractor from contract documents, including contract addendums issued prior to bid openings.
- .8 Include fault contribution of all motors in the study. Notify the Engineer in writing of circuit protective devices not properly rated for fault conditions.
- .9 Provide settings for the chiller motor starters or obtain from the mechanical contractor, include in the study package, and comment.
- .10 When an emergency generator is provided, include phase and ground coordination of the generator protective devices, to meet NEC 700.27 requirements. Show the generator decrement curve and damage curve along with the operating characteristic of the protective devices. Obtain the information from the generator manufacturer and include the generator actual impedance value, time constants and current boost data in the study. Do not use typical values for the generator.
- .11 Evaluate proper operation of the ground relays in 4-wire distributions with more than one main service circuit breaker, or when generators are provided, and discuss the neutral grounds and ground fault current flows during a neutral to ground fault.
- .12 For motor control circuits, show the MCC full-load current plus symmetrical and asymmetrical of the largest motor starting current to ensure protective devices will not trip major or group operation.

3.2.**FIELD SETTINGS**

- .1 The Contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short circuit study, protective device coordination study and arc flash risk

assessment.

- .2 Necessary field settings and adjustments of devices and minor modifications to equipment to accomplish conformance with the approved short circuit and protective device coordination study shall be carried out by the Contractor at no additional cost to the owner.

3.3.**ARC FLASH RISK ASSESSMENT**

- .1 As part of the short circuit and coordination study, arc flash risk assessment shall be included. The study shall include the following:
 - .1 Determine and document all possible utility and generator/emergency sources that are capable of being connected to each piece of electrical gear. Calculations shall be based on highest possible source connection.
 - .2 Calculations to conform to National Fire Protection Association (NFPA) 70E recognized means of calculation standards. All incident energy units shall be calculated in calories per square centimeter.
 - .3 Provide recommended boundary zones and personal protective equipment (PPE) based on the calculated incident energy and requirements of NFPA 70E for each piece of electrical gear.
 - .4 Electrical Contractor shall provide warning labels as required by OSHA based upon the results of the arc flash risk assessment. At a minimum, the labeling shall contain the following information: nominal system voltage, arc flash boundary, limited approach boundary, restricted approach boundary, available incident energy and the corresponding working distance or the arc flash PPE category, minimum arc rating of clothing, and study date. Label shall also include the name or logo and the phone number of the company performing the study.
 - .5 Arc flash warning labels shall be affixed to all electrical equipment that is likely to require examination, adjustment, servicing or maintenance while energized. This includes, but is not limited to, medium-voltage switchgear, transformers, switchboards, panel boards, three-phase disconnect switches, transfer switches, motor control centers, motor controllers, and three-phase motor disconnect switches.

END OF SECTION

1. General

1.1 RELATED WORK

- | | | |
|----|-------------------------------------|------------------|
| .1 | Motor Starters | Section 26 24 19 |
| .2 | Connections to Mechanical Equipment | Section 25 30 01 |

2. Products

2.1 NAMEPLATES

- .1 Lamacoid, white with black lettering except for equipment connected to the emergency supply for which orange nameplates with black letters are to be used.

3. Execution

3.1 IDENTIFICATION

- .1 Label every motor to show the motor number, the motor name and power source.
Example:

"MOTOR #3-51, EMERGENCY EXHAUST, CCT. EAA2-4"

Label every starter to show motor it controls. Coordinate with all Divisions, equipment names and numbers to be identical.

3.2 NAMEPLATES

- .1 Permanently fasten the nameplates to the equipment, so as to be clearly visible.

3.3 MOTOR SURVEY AND CONTROL WIRING DIAGRAMS

- .1 Make a complete survey of all electric motors. For every motor and starter, fill in the Motor Survey sheets illustrated herein. List each motor on a separate page. Attach a control wiring diagram neatly drawing in ladder form for each motor. Indicate all terminal and wire numbers. Identify all associated control components. Provide typed copies of these lists and diagrams in the Operating/Maintenance Manuals. Include motor overload selection charts for each type and application of overload relay.
- .2 Instruments used shall be digital with an accuracy of $\pm 2\%$.

END OF SECTION

1. General

1.1 INTENT

- .1 Provide demonstration and instruction sessions to familiarize Owner's operation and maintenance personnel with electrical systems and their operation and maintenance.
- .2 Submit system sign off sheets for each system listed after substantial completion.
- .3 Complete a motor survey sheet for each motor and submit after substantial completion. Include a control wiring diagram for each motor neatly drawn in ladder form. Indicate all terminal and wire numbers. Identify all associated control components. Provide typed copies of these lists and diagrams in the operating/maintenance manuals. Include motor overload selection charts for each type and application of overload relay.
- .4 All sign off and survey sheets shall be typewritten.

1.2 MANUFACTURER'S SITE SERVICES

- .1 Arrange and pay for appropriately qualified manufacturers representatives to provide or assist in providing electrical equipment and system demonstration and instruction as specified herein.

1.3 CONTRACTOR/OWNER COORDINATION

- .1 Owner will chair demonstration and instruction sessions.
- .2 Establish agendas for demonstration, commissioning and instruction sessions in conjunction with Owner. Coordinate scheduling of sessions with Owner and PCA Departmental Representative.

2. Products

- .1 NotApplicable

3. Execution

3.1 SYSTEMS DEMONSTRATION

- .1 Demonstrate operation of following systems:
 - .1 120/208 and 347/600 Volt System Emergency and Normal
 - .2 Pump Protection Panels
 - .3 Mechanical Equipment Connections and Controls
 - .4 Grounding System
 - .5 Intercom System
 - .6 Lighting
 - .7 Lighting Controls
 - .8 Future Connection Points and Conduit Stubs

MOTOR SURVEY SHEET

Motor Name & Number _____

Manufacturer _____

H.P. _____ Max. Ambient _____ °C

R.P.M. _____ Service Factor _____

Volts _____ / _____ / _____ Insulation Class _____

AMPS _____ / _____ / _____ EEMAC Design _____

PHASE _____ Time Rating _____

Frame _____ Type _____

Serial # _____

Model # _____

Starter _____ Type _____

Full Load Operating Amps _____ A _____ B _____ C _____

Capacitor Operating Amps _____ A _____ B _____ C _____

Full Load Operating Voltage _____ A-B _____ B-C _____ C-A _____

at Motor

Power Factor _____

Overload Relay Installed _____ Adjustable Setting _____ %

M.C.P. AMPS _____ Adjustable Setting _____

Acceleration Time (If over 7 seconds) _____

Reduced Voltage Starter Transition Time Setting _____

Special Controls and Remarks (Thermistor and Relay Type, Capacitors and where connected, etc.)

SYSTEM COMPLETION AND COMMISSIONING

SYSTEM: _____

The above system is installed as per the drawings and specifications, is complete and has been commissioned.

Electrical Contractor

Signed by: _____ Dated: _____

General Contractor

Signed by: _____ Dated: _____

Deficiencies Attached

This system has been reviewed by:

The Owner

Signed by: _____ Dated _____

The Owner's personnel have been instructed in the operation and maintenance of the above system:

The Owner

Signed by: _____ Dated _____

The above does not constitute a waiver of any of the requirements of the Contract Documents.

ELECTRICAL
CONTRACTOR

GENERAL
CONTRACTOR

	_____	_____
Address:	_____	_____
	_____	_____
	_____	_____
Phone:	_____	_____

END OF SECTION

1. General

1.1 RELATED WORK

- | | | |
|----|----------------------|------------------|
| .1 | Motor Starters | Section 26 24 19 |
| .2 | Motor Identification | Section 25 05 82 |
| .3 | Mechanical | Section 23 00 00 |

1.2 REQUIREMENTS

- .1 Provide a complete system of wiring to motors and controls as specified herein and as shown on the drawings.
- .2 Unless specifically noted otherwise, wire and leave in operation all electrically operated equipment supplied under all contracts related to this project. Examine the drawings and shop drawings of all Divisions for the extent of electrically operated equipment supplied under other contracts.
- .3 All control wiring diagrams shown on the drawings illustrate typical control circuits applicable to the equipment. Control circuits may vary with different manufacturers of equipment. Verify all control circuits with the suppliers of the equipment and make any corrections that may be required.
- .4 Unless specifically noted otherwise, provide all line voltage equipment such as, but not limited to, pushbuttons, relays, thermal overload protection, starters, conduit and wire, etc., necessary for the operation of equipment. Check all starters, relay coils and thermal elements to ensure that they provide the necessary protection for motors.
- .5 Do not operate motors and controls until approval is obtained from the trade providing equipment.
- .6 Examine drawings and shop drawings of other Divisions to obtain exact location of motors and equipment shown on drawings. Where necessary, obtain conduit locations from other trades' drawings and shop drawings.
- .7 Assist in placing in operation all mechanical equipment having electrical connections.
- .8 Provide three phase starters with fused 120 volt control transformers and overload relays.
- .9 Provide all power wiring for all motors and control wiring as indicated on the drawings.
- .10 In general, wiring for freeze stats, fire stats, E.P. switches, P.E. switches, dampers, temperature controllers, flow switches, solenoid valves, etc., for heating ventilating and air conditioning equipment will be under a separate contract. Provide terminations in starters and MCC's for control wiring so that starter control circuits may be extended. Where 120 volt power is required for mechanical equipment, i.e. roll type filters, refrigerated aftercoolers, control cabinets, etc. wiring to the equipment terminals is the work of this Division.
- .11 Refer to Motor Control Equipment Schedule.

- .12 Some specific definitions of equipment wiring responsibilities are as follows:
 - .1 Fans
 - .1 Provide all 120V and 208V power wiring. Except where specifically noted otherwise, all control for fans is to be supplied, installed and wired from the starter control circuits to the equipment under Division 23.
 - .2 Pumps for Domestic Water, Plumbing & Drainage Systems
 - .1 Provide all 208V and 120V wiring as shown on drawings. Except where specifically noted otherwise, all control for fans is to be supplied, installed and wired from the starter control circuits to the equipment under division 23.
 - .3 Unit Heaters
 - .1 Provide power wiring and starter for unit heater fans. Install and wire line voltage thermostats supplied by others. Where thermostats are low voltage or pneumatic, control wiring is under Division 23.
 - .4 Forced Flow Convectors
 - .1 Provide 120V power supply to the convectors. Starters, speed controllers and temperature controllers will be supplied and wired by Division 23.

2. Products

2.1 3 PHASE MOTOR DISCONNECT SWITCHES

- .1 Industrial Type "A", having quick make, quick break visible blade mechanism, cover interlocks and padlocking switch in the closed or open position. Use EEMAC 4 enclosures outdoors, and EEMAC 1 indoors switches to be H.P. rated, Westinghouse heavy duty type.

2.2 120 VOLT, 1 PHASE DISCONNECT SWITCHED

- .1 Manual starter without overload relay.

2.3 600 VOLT, 1 PHASE MOTOR DISCONNECT SWITCHES

- .1 Manual starter without overload relay.

3. Execution

3.1 INSTALLATION

- .1 Provide disconnect switches adjacent to all motors.

- .2 Provide all wiring between all force flow and unit heaters and their line voltage thermostats. Install wiring between all flow switches and valve monitors.
- .3 Do control wiring as indicated on the drawings and the motor control schedules.
- .4 Connection to motors and ancillary control equipment shall utilize liquid tight flexible metal conduit with adequately sized bonding conductor.
- .5 Division 26 shall wire up all controls where controls switch power lines directly, such as a line voltage thermostat.
- .6 Check phase rotation before energizing.
- .7 Connect up all motorized dampers and backdraft dampers as indicated on mechanical drawings or specified in mechanical specifications.
- .8 Provide relay / contactors as required, operated by built-in motor thermal protection devices (thermistors), for motors incorporating this type of overload protection.
- .9 Provide disconnects for boiler modules (one disconnect per module), and wire up low water cutoffs. Confirm horsepower of boiler burners with mechanical contractor.
- .10 Provide control power supply outlets and data outlets as required by Honeywell for operation of control panels and similar equipment. Allow for a separate circuit for each control panel unless otherwise indicated. Coordinate with Honeywell.
- .11 Provide power to sump pumps and associated control panel. Installation to meet requirements of CEC Section 22 and Inspection Authority.
- .12 Provide 120V connection to infrared sink, urinals & toilets controls. Provide and install GFCI receptacles for multi-station Bradley lavatories in the student washrooms.
- .13 Provide 120V, 15A, single phase circuit to each refrigerated drinking fountain. Coordinate exact location, and whether hard-wired or plug-in, with mechanical contractor.
- .14 Provide a 120V, 15A, single phase circuit for the interior lights on main ventilation unit.
- .15 Provide a 120V, 15A, single phase circuit to each flammable storage cabinet for power vent. Coordinate on site regarding exact location of cabinets and vent fan.
- .16 Provide single connection to dust collector control panel. From control panel wire up dust collector motor and shaker motor individually as per dust collector shop drawings. Interlock to the makeup air unit supply air into the CTS room. Control panel comes complete with necessary starters and control transformers.
- .17 Provide an empty conduit stub from every thermostat and sensor location shown on mechanical drawings, up to ceiling space. Coordinate with Honeywell.
- .18 Coordinate requirements for the foregoing with the mechanical trade.
- .19 Provide a 120V, 15A, single phase circuit to each Kiln Venting system.
- .20 Provide single phase circuit for internal lights on ventilation units.

3.2 VARIABLE FREQUENCY DRIVES

- .1 Loose variable frequency drives (VFDs) will be supplied by Div. 23, to control mechanical equipment requiring speed control. Electrical Contractor shall install VFDs, including all necessary line voltage wiring connections.
- .2 Packed VFDs on pumps will be supplied by the pump supplier.
- .3 VFDs are to be mounted as close the motor as possible.
- .4 Identify mounting requirements and include all materials and labour, including unistrut frames and plywood backboards, as per of this tender, as required to support VFDs if wall space is inadequate. Plywood used on unistrut frames to be minimum 19 mm thick, painted both sides with fire retardant intumescent paint.

- .5 Electrical Contractor should allow for line and load side connections to each VFD, as well as the supply and installation of a disconnect for each motor.

3.3 MOTORIZED ROLLER SHADES

- .1 Motorized roller shades are to be installed complete with controls and limit switches by Section 12 24 13. Run power to a junction box adjacent to each shade and connect up complete with recessed conduit. Install and connect up remote rocker switches. Each shade requires a 120V, 15A, single phase circuit.

3.4 Not used

.1

3.5 BARRIER FREE DOOR OPERATORS.

- .1 Provide power and control rough in and wiring for motorized doors for barrier free doors.
- .2 Barrier Free door push buttons shall be cabled with 2 pair 22 AWG – Decacom 40-101 (solid wire) or approved equivalent and the exterior door push button station shall be cabled with 2 pair 18 AWG – Decacom 74-316 (solid wire) or approved equivalent.
- .3 Provide a 120V, 15A, single phase circuit to each barrier free door operator motor. Refer to door hardware schedule in Section 08 70 00 and schematics on drawings for more information. See architectural door schedule for quantity and door type.
- .4 Final connections of Barrier Free Door. Push buttons by Barrier Free door supplier. Coordinate with Barrier Free Door Supplier.

END OF SECTION

1. General

1.1 SUMMARY

- .1 Section includes:
 - .1 General specification for the relay lighting control system
 - .2 The Electrical Contractors, as part of the work of this section, shall coordinate, receive, mount, connect and place into operation all equipment. The electrical contractor shall furnish all conduit, wire, connectors, hardware and other incidental items necessary for the complete and properly functioning relay lighting control system as described herein and shown on the plans.
- .2 Related sections:
 - .1 Section [262726 - Wiring Devices]
 - .2 Section [260923 – Lighting Control Devices:] Occupancy sensors used in conjunction with the lighting control system.
 - .3 Section [260943.13 – Digital-Network Lighting Controls:] Lighting control panels

1.2 REFERENCES

- .1 American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE)
 - .1 C62.41-1991 – Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
- .2 ASTM International (ASTM)
 - .1 D4674 -02a Standard Test Method for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Fluorescent Lighting and Window-Filtered Daylight
- .3 Canadian Standards Association (CSA) .
 - .1 CSA C22.2 # 14 Industrial Control Equipment
 - .2 CSA C22.2 # 184 Solid-State Lighting Controls
 - .3 CSA C22.2 # 156 Solid-State Speed Controls
- .4 European Commission (CE) - Harmonized European Standard.
 - .1 IEC/EN 60669-2-1 Switches for household and similar fixed electrical installations - electronic switches.
- .5 International Electrotechnical Commission .
 - .1 (IEC) 801-2 Electrostatic Discharge Testing Standard.
 - .2 IEC/EN 60669-2-1 Switches for household and similar fixed electrical installations - electronic switches.
- .6 International Organization for Standardization (ISO)
 - .1 9001:2000 – Quality Management Systems.
- .7 National Electrical Manufacturers Association (NEMA)
 - .1 WD1 (R2005) - General Color Requirements for Wiring Devices.
- .8 Norma Oficial Mexicana (NOM).

- .1 NOM-003-SCFI Productos eléctricos - Especificaciones de seguridad (Electrical products - Safety Specifications)
- .9 Underwriters Laboratories, Inc. (UL):
 - .1 489 (2002) - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
 - .2 508 (1999) - Standard for Industrial Control Equipment.
 - .3 924 (2003) - Emergency Lighting and Power Equipment

1.3 SYSTEM DESCRIPTION

- .1 Lighting Control System
 - .1 Factory assembled switching panels. [and] [interfaces and modules]
 - .2 Low voltage [wall stations] [and] [control interfaces] [and] [sensors].

1.4 SUBMITTALS

- .1 Submit under provisions of Section [013300.]
- .2 Specification Conformance Document: Indicate whether the submitted equipment either:
 - .1 Meets specification exactly as stated.
 - .2 Meets specification via an alternate means and indicate the specific methodology used.
- .3 Shop Drawings; include:
 - .1 Load schedule indicating actual connected load, load type, and voltage per circuit, circuits and their respective control zones, circuits that are on emergency, and capacity, phase, and corresponding circuit numbers.
 - .2 Schematic of system.
- .4 Product Data: Catalog cut sheets with performance specifications demonstrating compliance with specified requirements.

1.5 QUALITY ASSURANCE

- .1 Energy Management Lighting Control System:
 - .1 Listed by [CE] [CSA] [UL] specifically for the required loads. Provide evidence of compliance upon request.

1.6 PROJECT CONDITIONS

- .1 Do not install equipment until following conditions can be maintained in spaces to receive equipment:
 - .1 Ambient temperature: 0° to 40° C (32° to 104° F).
 - .2 Relative humidity: Maximum 90 percent, non-condensing.

- .3 Lighting control system must be protected from dust during installation.

1.7 WARRANTY

- .1 Provide manufacturer's 3 year parts warranty and a limited 10-year warranty shall be provided on all relay cards. These shall be standard warranties and will be in affect for all installations from the date of invoice.

1.8 MAINTENANCE

- .1 Make ordering of new equipment for expansions, replacements and spare parts available to end user.
- .2 Make new replacement parts available for minimum of ten (10) years from date of manufacture.
- .3 Provide toll free factory direct technical support hotline.
- .4 Provide on-site service support for troubleshooting within 24 hours anywhere in continental United States.
- .5 Offer renewable service contract on yearly basis, to include parts, factory labor and annual training visits. Make service contracts available up to ten (10) years after date of system commissioning.

2. Products

2.1 MANUFACTURERS

- .1 Acceptable Manufacturer: Eaton Lighting Systems (Formerly Cooper Controls) – Systems: ControlKeeper
- .2 Eaton Lighting Systems (Formerly Cooper Controls) Catalog Numbers:
- .1 ControlKeeper Metering [CKM]
 - .2 ControlKeeper Metering with Breakers [CKMB]
 - .3 ControlKeeper TouchScreen [CKT]
 - .4 ControlKeeper 4A [CK4A]
 - .5 ControlKeeper 4 [CK4]
 - .6 ControlKeeper 2 [CK2]
- .3 Substitutions: [Not permitted.] [Under provisions of Division 012500.]
- .4 All proposed substitutions (clearly delineated as such) must be submitted in writing for approval by the design professional a minimum of 10 working days prior to the bid date and must be made available to all bidders. Proposed substitutes must be accompanied by a review of the specification noting compliance on a line-by-line basis.
- .5 Any substitutions provided by the contractor shall be reviewed at the contractor's expense by the PCA Departmental Representative at a rate of [\$200.00] per hour.

- .6 By using pre-approved substitutions, the contractor accepts responsibility and associated costs for all required modifications to circuitry, devices and wiring. The contractor shall provide complete engineered shop drawings (including power wiring) with deviations for the original design highlighted in an alternate color to the engineer for review and approval prior to rough-in.

2.2 GENERAL

- .1 Provide hardware that is designed, tested, manufactured and warranted by a single manufacturer.
- .2 Lighting Controls: Ten-year operational life while operating continually at any temperature in an ambient temperature range of 0° C (32°F) to 40° C (104°F) and 90 percent non-condensing relative humidity.
- .3 Designed and tested to withstand electrostatic discharges up to 15,000 V without impairment per IEC 801-2.

2.3 PANEL / RELAY PERFORMANCE REQUIREMENTS

- .1 Electrolytic capacitors to operate at least 20° C below the component manufacturer's maximum temperature rating when device is under fully-loaded conditions in 40° C (104° F) ambient temperature.
- .2 Capable of withstanding repetitive inrush current of 50 times operating current without impacting lifetime of dimmer/relay.
- .3 Design and test relays to withstand line-side surges without impairment to performance.
 - .1 Panels: Withstand surges without impairment of performance when subjected to surges of 6,000 volts, 3,000 amps per ANSI/IEEE C62.41B.
- .4 Utilize air gap off, activated when user selects "off" at any control to disconnect the load from line supply.
- .5 Possess power failure memory such that if power is interrupted and subsequently returned, lights will automatically return to same levels (on or off) prior to power interruption within 3 seconds.
- .6 Non-dim circuits to meet the following requirements:
 - .1 Rated life of relay: Minimum 1,000,000 cycles.
 - .2 Load switched in manner that prevents arcing at mechanical contacts when power is applied to load circuits.
 - .3 Fully rated output continuous duty for inductive, capacitive and resistive loads.
- .7 Capable of controlling receptacle or plug loads with Latching Relay Option.
- .8 Power Metering Relay Cards to be used with the ControlKeeper Metering lighting panels CKMB.
 - .1 Individually Replaceable
 - .2 Minimum UL listed Short Circuit Current Rating (SCCR) of 65,000A.
 - .3 Rated life of relay: Minimum 1,000,000 cycles.

- .4 Load switched in manner that prevents arcing at mechanical contacts when power is applied to load circuits.
 - .5 Fully rated output continuous duty for inductive, capacitive and resistive loads.
 - .6 Capable of controlling receptacle or plug loads. PM-LRC
 - .7 Eaton Lighting Systems (Formerly Cooper Controls) Catalog Numbers: PM-SRC, PM-TPRC, PM-LRC
- .9 Serial Latching Relay Card to be used with the ControlKeeper lighting panels CKT, CK4A.
- .1 Rated life of relay: Minimum 1,000,000 cycles.
 - .2 Four 20amp relays at 120/277/347VAC
 - .3 Manual Override per relay
 - .4 Accepts up to 6 AWG wire
 - .5 Load switched in manner that prevents arcing at mechanical contacts when power is applied to load circuits.
 - .6 Fully rated output continuous duty for inductive, capacitive and resistive loads.
 - .7 Capable of controlling receptacle or plug loads.
 - .8 Eaton Lighting Systems (Formerly Cooper Controls) Catalog Numbers: sLRC
- .10 Serial Standard Relay Card to be used with the ControlKeeper lighting panels CKT, CK4A.
- .1 Rated life of relay: Minimum 1,000,000 cycles.
 - .2 Four 20amp relays at 120/277VAC
 - .3 Manual Override per relay
 - .4 Accepts up to 10 AWG wire
 - .5 Load switched in manner that prevents arcing at mechanical contacts when power is applied to load circuits.
 - .6 Fully rated output continuous duty for inductive, capacitive and resistive loads.
 - .7 Eaton Lighting Systems (Formerly Cooper Controls) Catalog Numbers: sSRC-NO
- .11 Serial Two Pole Relay Card to be used with the ControlKeeper lighting panels CKT,CK4A.
- .1 Rated life of relay: Minimum 1,000,000 cycles.
 - .2 Two 20amp relays at 208/240/480VAC (two pole)
 - .3 Manual Override per relay
 - .4 Accepts up to 6 AWG wire
 - .5 Load switched in manner that prevents arcing at mechanical contacts when power is applied to load circuits.
 - .6 Fully rated output continuous duty for inductive, capacitive, and resistive loads.
 - .7 Eaton Lighting Systems (Formerly Cooper Controls) Catalog Numbers: sTPRC-NO

2.4 POWER PANELS

- .1 Product: Eaton Lighting Systems (Formerly Cooper Controls) ControlKeeper Relay Panel with Breakers CKMB
- .2 Mechanical:
 - .1 Listed to ULC listed as industrial control equipment.
 - .2 Delivered and installed as a CSA listed factory assembled panel.

- .3 Field wiring accessible from front of panel without need to remove relay assemblies or other components.
 - .4 Panels passively cooled via free-convection, unaided by fans or other means.
 - .5 All panels include individual relay override and status LED as well as a Master Override switch. This allows the relays to be individually controlled without using the circuit breaker.
 - .6 [Surface mounted].
- .3 Electrical:
- .1 Panels contain branch circuit protection for each circuit unless the panel is a dedicated feed-through type panel or otherwise indicated on the drawings.
 - .2 Branch circuit breakers; meet following performance requirements:
 - .1 Listed to UL 489 as molded case circuit breaker for use on lighting circuits.
 - .2 Contain visual trip indicator; rated at up to 25,000 AIC.
 - .3 Thermal-magnetic construction for overload, short circuit and over-temperature protection. Use of breakers without thermal protection requires dimmers/relays to have integral thermal protection to prevent failures when overloaded or ambient temperature is above rating of panel.
 - .4 Accept tag-out/lock-out devices to secure circuit breakers in off position when servicing loads.
 - .5 Replaceable without moving or replacing relay assemblies or other components in panel.
 - .6 UL listed as switch duty (SWD) so that loads can be switched on and off by breakers.
 - .3 Minimum UL listed Short Circuit Current Rating (SCCR) of 65,000A.
 - .4 Rated life of relay: Minimum 1,000,000 cycles.
 - .5 Load switched in manner that prevents arcing at mechanical contacts when power is applied to load circuits.
 - .6 Fully rated output continuous duty for inductive, capacitive and resistive loads.
- .4 TouchScreen Panel Processor
- .1 Language selection: English
 - .2 Integral contact closure inputs.
 - .3 Integral 0-10V analog inputs
 - .4 Integral digital switch port
 - .5 Integral Serial Communication Port
 - .6 Integral USB Communication Port
 - .7 Integral Ethernet Communication Port
 - .8 Programming and system operation:
 - .1 Digital Switches, Network Commands and contact closure inputs
 - .1 Assign functionality of each input
 - .1 Select Relays or Groups of Relays
 - .2 Independent On/Off command functions (On/ Off/ No Command)
 - .3 Independent priorities per command (up to sixteen priority levels)
 - .4 Sixteen Mask features per panel
 - .1 Masking features include No On, No Off, Ignore, Reevaluate, No Timer based on time schedules and day of week programming.

- .5 Up to 999 minute timer
 - .6 Ability to issue and cancel Warn Off events
 - .2 Serial interface or Ethernet interface
 - .1 Communications protocol provided at no charge
 - .2 Any lighting panel can be monitored, programmed or controlled from any RS-232 or Ethernet connection
 - .3 Network Commands
 - .1 Any input can be programmed to broadcast its state or reading to the lighting control network
 - .2 Any input can be programmed as a Network Listener to receive state or reading from a broadcasted input.
 - .4 Contact closure output: Momentary, Maintained, Toggle
 - .1 Select Relays or Groups of Relays
 - .2 Independent On/Off command functions (On/ Off/ No Command)
 - .3 Independent priorities per command (up to sixteen priority levels)
 - .4 Sixteen Mask features per panel
 - .1 Masking features include No On, No Off, Ignore, Reevaluate, No Timer based on time schedules and day of week programming.
 - .5 Up to 999 minute timer
 - .6 Ability to issue and cancel Warn Off events
 - .2 Time clock
 - .1 Integral astronomical time clock
 - .1 Geographic location (city or latitude/longitude).
 - .2 Adjustable astronomic Offset (+) or (-)
 - .3 Adjustable date and time format.
 - .4 Adjustable starting and ending of daylight savings time.
 - .5 Selectable day of week time event programming
 - .6 Select Relays or Groups of Relays
 - .7 Independent On/Off command functions (On/ Off/ No Command)
 - .8 Independent priorities per command (up to sixteen priority levels)
 - .9 Review and modify time clock schedule to add, copy, modify and delete events.
- .5 Diagnostics and Service:
 - .1 Replacing relay does not require re-programming of system or processor.
 - .2 Relays: Include diagnostic LED's to verify proper operation and assist in system troubleshooting.
 - .3 Relay panels: Include tiered control scheme for dealing with component failure that minimizes loss of control for occupant.
 - .1 Failures on the lighting control system network are localized to the failed product. All other lighting control panels continue to fully function without Additionalaction. Systems that have a single point of failure on the network shall not be acceptable.
 - .4 If lighting control system fails, lights to remain at current level. Individual relay overrides provides local control of lights until system is repaired. Each lighting

control panel include a master override to override the entire lighting panel.

- .6 Real Time Energy Meter per circuit
 - .1 Real Time Energy Metering data shall be supported via integral power metering circuitry on certain ControlKeeper Lighting Panels. [CKM], [CMKB]
 - .1 Electrical device to provide real time power metering of voltage and current shall be provided with each relay.
 - .2 Metered data can be polled via public command string from the on board Ethernet input.
 - .3 Metered data shall be reported based on actual connected relay load.

2.5 LOW VOLTAGE WALL STATIONS

- .1 Product: Greengate Digital Switch white.
- .2 Electronics:
 - 1. Use Eaton Lighting Systems (Formerly Cooper Controls) LCCP or LCCNP wire for low voltage communication wiring for the Greengate Digital Switch.
 - 2. Use 18 AWG wire for low voltage dry contact switches. Number of conducts is based on type of switch.
- .3 Functionality:
 - .1 Upon button press, LEDs to immediately illuminate.
 - .2 LEDs to reflect the true system status. LED state is programmable to reflect either relay state or button push state.
 - .3 Allow for easy reprogramming without replacing unit.
 - .4 Replacement of units does not require reprogramming.
- .4 Provide faceplates with Low Voltage Wall Stations
- .5 Engrave wall stations with appropriate button, zone and scene engraving descriptions furnished prior to fabrication.

2.6 LOW VOLTAGE CONTROL INTERFACES

- .1 Contact Closure
 - .1 Integral contact closures to accept both momentary and maintained contact closures.
 - .2 Systems that do not include integral contact closures shall not be acceptable.
- .2 Serial Interface
 - .1 Provide ability to communicate by means of serial communication by means of user-supplied PC or digital audiovisual equipment. Control to be located within 50 feet (15 meters) of source.
 - .2 Communications protocol to provide access to:
 - .1 Individual Relay Commands
 - .2 Individual Relay Status
 - .3 Input Status
 - .4 Network Override Commands
 - .3 Provide full programming, monitoring and override control using Keeper Enterprise Programming software.

- .3 Ethernet Interfaces; Eaton Lighting Systems (Formerly Cooper Controls) Model Ethernet Interface Module
 - .1 Provide ability to communicate by means of TCP/IP over Ethernet to ControlKeeper lighting control system by means of user-supplied PC or digital audiovisual equipment. Control to be located within 300 feet (100 meters) of Ethernet source.
 - .2 Communications protocol to provide access to:
 - .1 Individual Relay Commands
 - .2 Individual Relay Status
 - .3 Input Status
 - .4 Network Override Commands
 - .3 (Optional) Provide full programming, monitoring and override control using Keeper Enterprise Programming software.
 - .4 (Optional) The lighting zones may be controlled through a graphical representation software package called VisionTouch®. The software permits up to 255 floors or site plans to be illustrated for intuitive control. The software provides real-time feedback to the operator of network control overrides and relay status.
 - .5 (Optional) The lighting zones may be controlled through a graphical representation of four switches on multiple PC's that are connected to the building LAN. This software package for lighting control overrides is called VisionSwitch®. The software permits unlimited users connected to the building LAN to control their lighting zones. The software provides immediate feedback to the operator/user of network control overrides.
 - .6 (Optional) The lighting zones may be controlled using standard calendar based scheduling software. Create events which include individual and groups of relays and link them to any time and day on the calendar. This software package for lighting control event scheduling is called Event Manager. This software requires a SQL Server for operation connected to the lighting control system via the Ethernet Interface Module.
- .4 BACnet Interface; Eaton Lighting Systems (Formerly Cooper Controls) Model AIM B NW:
 - .1 The ControlKeeper® network shall permit data protocol translation through a building automation interface Gateway. The BACnet Gateway shall permit BACnet communication protocol to operate individual relays, relay groups and read the status of those relays. The ControlKeeper® network shall respond efficiently to the requested information from the BACnet network.
 - .2 Provide PIC list definition and object model to other system manufacturers.
- .5 LonWorks Interface; Eaton Lighting Systems (Formerly Cooper Controls) Model AIM L NW:
 - .1 Provide ability to communicate by means of LonWorks FTT-10 communication to centralized lighting system from user-supplied LonWorks FTT-10 twisted pair network.
 - .2 The ControlKeeper® network shall permit data protocol translation through a building automation interface Gateway. The LON Gateway shall permit LonWorks communication protocol to operate individual relays, relay groups and read the status of those relays. The ControlKeeper® network shall respond efficiently to the requested information from the LonWorks network.
 - .3 Provide LonWorks interface object model specification to secondary equipment manufacturers.
- .6 Emergency Lighting Interface; Eaton Lighting Systems (Formerly Cooper Controls) Model LRM120
 - .1 Provides total system listing to UL 924 when used with ControlKeeper system.

- .2 Senses the loss of normal power.
- .3 Provides an output to override the ControlKeeper lighting panels to the all On state.

2.7 SENSORS

- .1 Refer Section 260923 – Lighting Control Devices and drawings: Occupancy sensors used in conjunction with the lighting control system.
- .2 Exterior Daylight Sensors:
 - .1 Calibrated with independent turn-on and turn-off thresholds; minimum 2 foot-candles difference between the turn-on and turn-off thresholds.
 - .2 Enclosed in weatherproof housing with shading and lens protection visor.

2.8 OPEN ADR VIRTUAL END NODE (VEN) FOR DEMAND RESPONSE

- .1 The ControlKeeper shall be capable of receiving a signal from a Demand Response or OpenADR Virtual End Node device. When received the ControlKeeper will automatically adjust lighting to provide optimal energy savings and comply with Demand Response code requirements. Systems that do not support Demand Response capability shall not be acceptable.
 - .1 Automatically adjust the target lighting level by at least 15% but not more than 50%.
 - .2 System does not permit user override of the Demand Response system except in the cases of emergency or normal power loss. Systems that allow the user to adjust the lights higher than the demand response target light level shall not be acceptable.
 - .3 Each ControlKeeper shall be configurable for individual Demand Response reduction levels. Systems that only support global Demand Response reduction levels shall not be acceptable.
- .2 Eaton Lighting Systems (Formerly Cooper Controls) Catalog Number:
 - .1 EBOX-2B-DC

2.9 EMERGENCY LIGHTING

- .1 Emergency Power Control – A UL 924 listed device installs down line of an output that monitors a switched or dimmed circuit providing normal lighting to an area. The unit provides normal ON/OFF or 0-10V dimming control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:
 - .1 120/208 volts, 50/60 Hz, 20 amp ballast rating.
 - .2 Push to test button.
 - .3 Eaton Lighting Systems (Formerly Cooper Controls) Catalog Numbers:
 - .1 CEPC-1 (switching)
 - .2 CEPC-1-D (0-10V dimming)

2.10 ACCESSORIES

- .1 The ControlKeeper® has several hardware accessories that may be utilized to enhance your lighting control application. Select from the network hardware accessories which accessories will be utilized for your application.

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- .1 ControlKeeper® TouchScreen (CKT)
 - .1 The CKT shall provide additional flexibility by providing up to 48 - 20 amp @ 277 VAC rated relays that are addressable and fully programmable from the network. The relay wire terminations shall be able to accept 10 AWG. The CKT controllers, although accessible through the network, shall be fully stand-alone in their control capability. The CKT provides full status indication of CPU status, network communication, power, and HOA overrides. The controller shall provide thirty-two, 3-wire or 2-wire dry contact inputs that may be configured as maintained or momentary inputs. The controller shall provide four analog inputs. The controller shall provide up to 64 digital buttons for overrides. The controller shall provide 128 additional global commands for network control and shall reside in the CKT. Networks that rely on a single time clock for system operation shall not be acceptable.
 - .2 ControlKeeper® 4A (CK 4A)
 - .1 The CK 4A shall provide additional flexibility by providing four 20 amp @ 277 VAC rated relays that are addressable and fully programmable from the network. The relay wire terminations shall be able to accept 10 AWG. The CK 4A shall optionally provide four, 0-10VDC outputs to control dimming ballasts. The CK 4A controllers although accessible through the network shall be fully stand-alone in their control capability. The CK 4A provides full status indication of CPU status, network communication, power and HOA overrides. The controller shall provide four, 3-wire or eight, 2-wire dry contact inputs that may be configured as maintained or momentary inputs. The controller shall provide four analog inputs. The controller shall provide up to 64 digital buttons for overrides. The controller shall provide 64 additional global commands for network control and shall reside in the CK 4A. Networks that rely on a single time clock for system operation shall not be acceptable.
 - .3 ControlKeeper® 4 (CK 4)
 - .1 The CK 4 shall provide additional flexibility by providing four normally open or normally closed 20 amp @ 277 VAC rated relays that are addressable and fully programmable from the network. The relay wire terminations shall be able to accept 10 AWG. The CK 4 controllers although accessible through the network shall be fully stand-alone in their control capability. The CK 4 provides full status indication of CPU status, network communication, power and HOA overrides. The controller shall provide four dry contact inputs that may be configured as maintained or momentary inputs. The controller shall provide up to 64 digital buttons for overrides. The controller shall provide 64 additional global commands for network control and shall reside in the CK 4. Systems that utilize the master slave topology shall not be acceptable.
 - .4 ControlKeeper® 2 (CK 2)
 - .1 The CK 2 shall provide additional flexibility by providing two normally open or normally closed 20 amp @ 277 VAC rated relays that are addressable and fully programmable from the network. The relay wire terminations shall be able to accept 10 AWG. The CK 2 controllers although accessible through the network shall be fully stand-alone in their control capability. The CK 2 provides full status indication of CPU status, network communication, power, and HOA overrides. The controller shall provide two dry contact inputs that may be configured as maintained or momentary inputs. The controller shall provide up to 64 digital buttons for overrides. The controller shall provide 64 additional global commands for network control and shall reside in the CK 2. Systems that utilize the master slave topology shall not be acceptable.

2.11 SOURCE QUALITY CONTROL

- .1 Perform full-function testing on completed assemblies at end of line. Statistical sampling is not acceptable.

3. EXECUTION

3.1 EQUIPMENT INSTALLATION AND DOCUMENTATION

.1 Installation

The control system shall be installed and fully wired as shown on the plans by the installing contractor. The contractor shall complete all electrical connections to all control circuits and override wiring.

.2 Documentation

The contractor shall provide accurate "as-built" drawings to the owner for correct programming and proper maintenance of the control system. The "as-builts" shall indicate the load controlled by each relay and the relay panel number.

.3 Operation and Service Manuals

The factory shall supply all operation and service manuals.

3.2 PRODUCT SUPPORT AND SERVICE

.1 Factory Support

Factory telephone support shall be available at no cost to the owner. Factory assistance shall consist of solving programming or application questions concerning the control equipment.

3.3 SYSTEM DELIVERY AND ACCEPTANCE

.1 Delivery

The contractor is responsible for complete installation of the entire system according to strict factory standards and requirements. The following items shall constitute factory standards and requirements:

- .1 All system equipment shall operate in accordance with specification and industrial standard procedures.
- .2 An operational user program shall exist in the control system. The program shall execute and perform all functions required to effectively operate the site according to the requirements.
- .3 Demonstration of program integrity during normal operation and pursuant to a power outage.
- .4 Contractor shall provide a minimum of two training hours on the operation and use of the control system. Additional support services shall be negotiated between the contractor and the building owner or manager.

3.4 FACTORY COMMISSIONING (OPTIONAL)

- .1 Upon completion of the installation, the system shall be commissioned by the manufacturer's factory authorized representative who will verify a complete fully functional system.

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- .2 The electrical contractor shall provide both the manufacturer and the PCA Departmental Representative with twenty one working days written notice of the system startup and adjustment date.
 - .3 Upon completion of the system commissioning the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system.

3.5 WARRANTY

.1 Warranty

Manufacturer shall supply a 3-year warranty on all hardware and software. A limited 10-year warranty shall be provided on all relay cards. These warranties will be in affect for all installations. Systems that provide special warranties based on installation shall not be acceptable.

END OF SECTION

1. General

1.1 RELATED SECTIONS

- .1 Section 26 09 23 Low Voltage Switching.

1.2 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 26 05 01.
- .2 Data to indicate system components, mounting method, source of power and special attachments.
- .3 Supplier shall substantiate conformance to this specification by supplying the necessary documents, performance data and wiring diagrams. Any deviations to this specification must be clearly stated by letter and submitted.
- .4 After award of tender, the Owner shall supply to the occupancy sensor supplier drawings showing the proposed location and type of all occupancy sensors. The supplier shall submit this lighting plan, clearly marked showing proper product, location and orientation of each sensor.
- .5 Submit any interconnection diagrams per major subsystem showing proper wiring.
- .6 Submit standard catalog literature that includes performance specifications indicating compliance to the specification.
- .7 Catalog sheets must clearly state any load restrictions when used with electronic ballasts.
- .8 At conclusion of commissioning period, supplier shall provide a spreadsheet listing the final setting of each parameter (sensitivity, time delay, orientation) of each sensor.

1.3 WORK INCLUDED

- .1 Supplier's scope of work to include all materials, appliances, control hardware, sensors, swivel mounting brackets, and equipment necessary for and incidental to the delivery and commissioning of a completely operational occupancy sensor lighting control system, as described herein. This contractor shall provide all labour, tools, wire, junction boxes, and equipment necessary for and incidental to the installation of the system.
- .2 Supplier shall examine all specification provisions and drawings for related electrical work required as work under Division 26. System shall be fully compatible with low voltage switching system in Section 26 09 23.
- .3 This contractor shall coordinate all work described in this section with all other applicable plans and specifications, including but not limited to wiring, conduit, fixtures, HVAC systems and building management systems except as otherwise specified.

1.4 EQUIPMENT QUALIFICATION

- .1 Products supplied shall be from a single supplier that have been continuously involved in manufacturing of occupancy sensors. Mixing of suppliers shall not be allowed.
- .2 All components shall be CSA or CUL certified and met all applicable code requirements.

- .3 Wall switch products must be capable of withstanding the effects of inrush current. Submittals shall clearly indicate the method used.

1.5 SYSTEM DESCRIPTION

- .1 The objective of this section is to ensure the proper installation of the occupancy sensor based lighting control system so that lighting is turned off automatically after reasonable time delay when a room or area is vacated by the last person to occupy said room or area.
- .2 The occupancy sensor based lighting control shall accommodate all conditions of space utilization and all irregular work hours and habits.
- .3 Occupancy sensor shall work in cases where the light fixtures are eight line voltage switched or where they are low voltage switched.
- .4 Supplier shall warrant to this contractor all equipment furnished in accordance to this specification to be undamaged, free of defects in materials and workmanship, and in conformance with specifications for a period of five (5) years. The supplier's obligation shall include repair or replacement, and testing without charge to the Owner, all or any parts of equipment which are found to be damaged, defective or non-conforming and returned to the supplier. The warranty shall commence upon the Owner's acceptance of the project.

2. Products

2.1 COMPONENT REQUIREMENTS

- .1 Wall switch sensors shall be capable of detection of occupancy at desktop level up to 30 m², and gross motion up to 100 m².
- .2 Wall switch sensors shall accommodate loads from 0 to 800 W at 120V; 0 to 1500 W at 120V and shall have 180° coverage capability with adjustable internal shutters to reduce coverage.
- .3 Wall switch products shall utilize zero crossing circuitry which increases relay life, protects from the effects of inrush current and increase sensor's longevity.
- .4 Wall switch sensors shall have no leakage current to load, in manual or in Auto / Off mode for safety purposes and shall have voltage drop protection.
- .5 Wall switch sensors shall provide a field selectable option to convert sensor operation from automatic-ON to manual-ON.
- .6 Where specified, vandal resistant wall switch sensors shall utilize a hard lens with a minimum 1.0mm thickness. Product utilizing a soft lens will not be considered.
- .7 Passive infrared sensors shall utilize pulse count processing and digital signature analysis to respond only to those signals caused by human motion.
- .8 Passive infrared sensors shall provide high immunity to false triggering from RFI (hand-held radios) and EMI (electrical noise on the line).
- .9 Passive infrared sensors shall have a multiple segmented Fresnel lens, in a multiple-tier configuration, which grooves in to eliminate dust and residue build-up.

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- .10 Daylighting control shall be accomplished by separate photo sensors and daylight sensors. Photo sensors are described under section 26 06 24 for relay controlled lights. Daylight sensor to be single zone, on / off switching type, automatic calibrations, easy to read LCD display & LED status. Allow for onsite calibration by Electrical Contractor.
 - .11 Dual technology sensors shall be either corner mounted or ceiling mounted in such a way as to minimize coverage in unwanted areas. Wiring shall be brought from the ceiling in either case.
 - .12 Dual technology sensors shall consist of passive infrared and ultrasonic technologies for occupancy detection. Products that react to noise or ambient sound shall not be considered.
 - .13 Ultrasonic sensors shall utilize advanced signal processing to adjust the detection threshold dynamically to compensate for constantly changing levels of acidity and air flow throughout controlled space.
 - .14 Ultrasonic operating frequency shall be crystal controlled at nominally 40 kHz within $\pm 0.002\%$ tolerance to assure reliable performance and eliminate sensor cross-talk. Sensors using multiple frequencies are not acceptable.
 - .15 Sensors that cause interference with patients using cochlear implants or hearing aids are not acceptable and will be replaced by suitable project within the five (5) year warranty period at the supplier's expenses.
 - .16 All sensors shall be capable of operating normally with electronic ballasts, LED drivers compact fluorescent lamp system and rated motor loads.
 - .17 Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioner or heating fans.
 - .18 Sensors shall utilize technology for automatically adjustable time delay and sensitivity settings.
 - .19 All sensors shall have readily accessible, user adjustable settings for time delay and sensitivity. Settings shall be located on the sensor (not the control unit) and shall be recessed to limit tampering.
 - .20 In the event of failure, a bypass manual override shall be provided on each sensor. When bypass is utilized, lighting shall remain on constantly or control shall divert to a wall switch until sensor is replaced. This control shall be recessed to prevent tampering.
 - .21 All sensors shall provide an LED as a visual means of indication at all times to verify that motion is being detected during both testing and normal operation.
 - .22 Sensor shall have an internal additional isolated relay with Normally Open, Normally Closed and Common outputs for use with HVAC control, Data Logging and other control options. Sensors utilizing separate components or specially modified units to achieve this function are not acceptable.
 - .23 All sensors shall have UL rated, plastic enclosures, white finish.
 - .24 All sensors shall have auxiliary contacts.

2.2 CIRCUIT CONTROL HARDWARE

- .1 Control units (power packs and auxiliary relay or slave packs): for ease of mounting, installation and future service, control unit(s) shall be able to externally mount through at 16 mm knock-out on a standard electrical enclosure and be an integrated, self-contained unit consisting internally of an isolated load switching control relay and a transformer (except slave packs) to provide low-voltage power. Control unit provide power to a minimum of two (2) sensors.
- .2 Relay contacts shall have ratings of 3A – 120 Vac tungsten, 20A – 120 Vac ballasted.
- .3 Control wiring between sensors and controls units shall be Class II, No. 18-24 AWG, stranded CSA certified, PVC insulated or TEFLON jacketed cable suitable for use to plenums, FT-4 or CMR rated.
- .4 Minimum acceptable wire gauge from the circuit control hardware relays shall be #214 AWG.

2.3 ACCEPTABLE MANUFACTURERS

- .1 Refer to table below for applicable sensor types. Actual sensor type and location within the room shall be recommended by the supplier. All catalog numbers below refer to project manufactured by The Watt Stopper Inc. All sensors are to be suitable for mounting to outlet boxes. Acceptable manufacturers are Leviton and sensor switch.

- .2 Ceiling sensors:

Type	Technology	Coverage Area (at 80%)	Standard of Acceptance
C1	Ultrasonic	45 m ²	WT-600
C2	Ultrasonic	85 m ²	WT-1100
C3	Passive Infrared	37 m ²	C-200-1
C4	Dual Technology	74 m ²	DT-300
C5	Ultrasonic	19 lineal m	WT-2250
C6	Passive Infrared	22 m ²	WPIR
C7	Passive Infrared	150 m ²	CX-100

- .3 Control Unit:

- .1 Power Packs: Power supplied from low voltage lighting control system. Locate power packs near occupancy sensors as recommended by manufacturer.

3. Execution

3.1 INSTALLATION

- .1 The supplier shall recommend prior to rough-in any changes to quantity or location of sensors in order to adequately provide coverage for the room. It shall be this contractor's responsibility to locate and aim sensors in the correct location required for complete and proper volumetric within the range of coverage(s) of controlled areas per the supplier's recommendations.
- .2 Rooms shall have ninety (90) to one hundred (100) percent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants

at any location within the room(s). The locations and quantities of sensors shown on the drawings are diagrammatic and indicate the rooms which are to be provided with sensors.

- .3 It is the supplier's responsibility to arrange for supplier's factory authorized representative to attend pre-installation meetings at the project site, to verify placement of sensors and installation criteria prior to rough-in.
- .4 Proper judgment must be exercised in executing the installation so as to ensure the best possible installation in the available space to overcome local difficulties due to space limitations or interference of structural components. The supplied shall also provide, at the Owner's facility, the training necessary to familiarize the Owner's personnel with the operation, use, adjustment, and problem solving diagnosis of the occupancy sensing devices and systems.
- .5 All sensors shall initially be set to a 15 minute time delay user adjustable from 1 s to 30 min), except where otherwise noted on the drawings.
- .6 Sequence of operation shall be as follows: When motion is detected, the occupancy sensor starts its time-out timer and sends an ON signal to the relay scanner to activate associated relays, and also enables the daylight sensors, and turn the light on. Whenever motion is again detected, the time-out timer is reset to zero time. The time-out timer only expires when no motion has occurred during a time equal to the time-out setting. Upon time-out expiry, the occupancy sensor sends an OFF signal to the relay scanner and disables the daylight sensors, and turns the lights off.

3.2 COMMISSIONING

- .1 Upon completion of the installation, in conjunction with the Contractor and the Owner, the entire system shall be completely commissioned by the supplier's factory authorized technician. This team will verify all adjustments and sensor placements to ensure a trouble-free occupancy-based lighting control system

END OF SECTION

1. General

1.1 SECTION INCLUDES

- .1 Low Voltage Switchboard – Furnish and install switchboard(s) as specified herein and where shown on the associated schedules and drawings.

1.2 REFERENCES

- .1 The switchboard(s) and overcurrent protection device(s) referenced herein are designed and manufactured according to the latest revision of the following specifications.
 - .1 Switchgear assemblies: CSA C22.2 No.31
 - .2 UL891
 - .3 Panelboards: CSA C22.2 No.29
 - .4 Molded Case Circuit Breakers: CSA C22.2 No. 5
 - .5 UL489
 - .6 Enclosed Switches: CSA C22.2 No. 4

1.3 SUBMITTAL AND RECORD DOCUMENTATION

- .1 Approval documents shall include drawings. Drawings shall indicate front and side enclosure elevations with overall dimensions shown; conduit entrance location and requirements, single-line diagrams, equipment schedule and switchboard instrument details.

1.4 QUALIFICATIONS

- .1 Company specializing in manufacturing of switchboard products.
Switchboards shall be manufactured in accordance with standards listed Article
- .2 1.02 – REFERENCES.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Inspect and report concealed damage to carrier within their required time period.
- .2 Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.
- .3 Store in a clean, dry environment. Maintain factory packaging and, if required, provide an additional heavy canvas or heavy plastic cover to protect enclosure(s) from dirt, water, construction debris, and traffic.

1.6 OPERATIONS AND MAINTENANCE MATERIALS

- .1 Manufacturer shall provide installation instructions:
 - Instructions for Safe Installation, Operation and Maintenance of Switchboards Rated 600 Volts or less.

1.7 WARRANTY

- .1 Manufacturer shall warrant specified equipment free from defects in materials and workmanship for the lesser of one (1) year from the date of installation or eighteen (18) months from the date of purchase.

1.8 RELATED SPECIFICATIONS

- .1 Section 260526 – Grounding and Bonding
- .2 Section 261313 – Enclosed Circuit Breakers
- .3 Section 262313 – Enclosed Switches
- .4 Section 262416 – Panelboards
- .5 Section 264300 – Surge Protective Device (SPD)
- .6 Section 262300 – Low-Voltage Switchgear
- .7 Section 26091380 – Web Enabled Power Distribution
- .8 Section 26091310 – Electrical Power Monitoring and Control

2. Products

2.1 MANUFACTURERS

- .1 Shall be Square D Company
- .2 Substitutions must be submitted in writing three weeks prior to original bid date with supporting documentation demonstrating that the alternate manufacturer meets all aspects of the specification herein.

2.2 TERMINATIONS

- .1 Termination lugs shall be CSA/UL Listed to accept solid or stranded [copper and aluminum conductors] [copper conductors only]. Termination lugs shall be suitable for cables sized per the 75C column of the CE Code table. It is permissible for primary cables terminating in a bussed auxiliary section to be sized to the 90C column of the CE Code.

2.3 ENCLOSURE

- .1 The switchboard shall be totally enclosed, dead front, freestanding or freestanding wall supported, and rear aligned with front, side or rear access.
- .2 The switchboard shall be NEMA Type 1 – with drip hood.
- .3 NEMA Type 1 enclosure shall be Sprinkler Protection CEC26-008.
- .4 The framework shall be formed steel and secured together to support all cover plates, bussing and component devices during shipment and installation. All closure plates are to be single tool, screw removable. Ventilation shall be provided when required. Each section shall include a single-piece removable top plate.
- .5 The switchboard enclosure shall be painted on all exterior surfaces. The paint finish shall be ASA49 grey unless otherwise specified.
- .6 Steel base channels shall be bolted to the frame to rigidly support the entire shipping section for moving on rollers and for floor mounting. An option of a steel base channel shall be made available

2.4 BUSSING

- .1 The switchboard shall be high conductivity solid silver-plated copper bus.
- .2 The through bus shall have a maximum ampacity of 400A, 600A, 800A, 1,000A, 1200A, 1600A. The switchboard bussing shall be of sufficient cross-sectional area to meet the CSA C22.2 No. 31 standard for temperature rise.
- .3 The switchboard shall be rated with a minimum short circuit rating of 50,000A at 208Vac.
- .4 Provisions shall be made for future splicing of additional sections.
- .5 All bolts used on bus bar joints shall be a minimum of grade 5.
- .6 The utility metering compartment shall have provisions for window type/bar type current transformers as supplied by the applicable public utility.

2.5 MAIN DISCONNECT DEVICES

- .1 Main Circuit Breaker
 - .1 Electronic trip molded case, full function, circuit breaker
 - .1 Shall be rated for 80% continuous current and be PowerPact P or R style breaker with MICROLOGIC trip system.
 - .2 Shall be rated for 100% continuous current and be PowerPact P or R style breaker with MICROLOGIC trip system.
 - .3 Rated ampacity shall be 1000A, 1200A, 1600A See drawings.
 - .2 Thermal magnetic molded case circuit breaker
 - .1 Shall be rated for 80% continuous current and be PowerPact M, P or R style breaker with standard electronic trip system.
 - .2 Rated ampacity shall be 1000A, 1200A, 1600A See drawings.
 - .1 Stored energy electronic trip insulated case circuit breaker
 - .2 Shall be a MASTERPACT NW, two-step stored energy circuit breaker.
 - .3 Rated ampacity shall be 1000A, 1200A, 1600A See drawings
 - .4 Circuit breaker(s) shall have 10kA, 14kA, 18kA 25kA 35kA 42kA 50kA 65kA interrupting capacity at 208Vac. See drawings.
 - .5 Shall be rated for 100% continuous current.
 - .6 Provide a fixed instantaneous (High Level Selective Override) circuit on breaker(s). The circuit shall have a defeatable instantaneous adjustment to allow the breaker to remain closed for up to 30 cycles during overcurrents below the rms symmetrical short time withstand ratings. The circuit shall instantaneously trip when current levels exceed applicable withstand ratings.
 - .7 Electronic Trip System

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- .1 Circuit breaker trip system shall be a **MICROLOGIC** electronic trip unit.
 - .2 All trip units shall be removable to allow for field upgrades.
 - .3 Trip Units shall incorporate "True RMS Sensing" and have LED long-time pickup indications.
 - .4 **MICROLOGIC** trip unit functions shall consist of adjustable long-time pickup and delay, [optional short-time pickup and delay], instantaneous [optional neutral protection and optional ground-fault pickup and delay].
 - .5 Adjustable long-time pickup (I_r) and delay shall be available in an adjustable rating plug that is UL Listed as field-replaceable. Adjustable rating plug shall allow for nine long-time pickup settings from 0.4 to 1 times the sensor plug (I_n). Other adjustable rating plugs shall be available for more precise settings to match the application. Long-time delay settings shall be in nine bands from 0.5–24 seconds at six times I_r .
 - .6 [Short-time pickup shall allow for nine settings from 1.5 to 10 times I_r . Short-time delay shall be in nine bands from 0.1–0.4 $I_2 t$ ON and 0–0.4 $I_2 t$ OFF.
 - .7 Instantaneous settings on the trip units with LSI protection shall be available in nine bands from 2 to 15 times I_n . The Instantaneous setting shall also have an OFF setting when short-time pick-up is provided.
 - .8 All trip units shall have the capability for the adjustments to be set and read locally by rotating a switch. [Optional: trip units shall have the capability to electronically adjust the settings locally and remotely to fine increments below the switch settings. Fine increments for pickup adjustments are to be one ampere. Fine increments for delay adjustments are to be one second.
 - .9 Trip unit shall provide local trip indication [and capability to indicate local and remote reason for trip, i.e., overload, short circuit or ground fault.
 - .10 [Ground-fault protection shall be available for solidly grounded three-phase, three-wire or three-phase, four-wire systems. Trip unit shall be capable of the following types of ground-fault protection: residual, source ground return, and modified differential. Ground-fault sensing systems may be changed in the field.
 - .11 [Ground-fault settings for circuit breaker sensor sizes 1200 A or below shall be in nine bands from 0.2 to 1.0 times I_n . The ground-fault settings for circuit breakers above 1200 A shall be nine bands from 500 to 1200 A.
 - .12 [Neutral current transformers shall be available for four-wire systems.
 - .13 Trip units shall be capable of communicating on four wire **MODBUS**® networks without software interfaces (black boxes).
 - .14 Trip units shall be available to provide additional protection by offering adjustable inverse definite minimum time lag (IDMTL). IDMTL provides optimized coordination by the

- adjustment of the slope of the long-time delay protection.
- .15 Trip units shall be available to provide real time metering. Metering functions include current, voltage, power and frequency. Metering accuracy shall be 1.5% current, 0.5% voltage, and 2% power. These accuracies include CT and meter.
- .16 Trip units shall be available to provide harmonic analysis and waveform capture.
- .17 A means to seal the trip unit adjustments in accordance with NEC Section 240-6(b) shall be provided.
- .18 The following table indicates the standard and optional features of the Trip Units. Select the appropriate trip unit (s) for the system performance desired.

Features	Micrologic Trip Unit Series			
	Standard	A	P	H
True RMS Sensing	X	X	X	X
LI	X	X	X	X
LSI	o	o	X	X
LSIG/Ground –Fault Trip		o	o	o
Ground Fault Alarm (no trip)			X	X
Ground Fault Trip and Programming Alarm			o	o
Adjustable Rating Plugs	X	X	X	X
LED - Long-time Pickup	X	X	X	X
LED - Trip indication		X	X	X
Digital Ammeter		X	X	X
Phase loading Bar Graph		X	X	X
Zone Selective Interlocking		X	X	X
Communications		o	X	X
LCD Dot Matrix Display			X	X
Advanced User Interface			X	X
Protective Relay Functions			X	X
Thermal Imaging			X	X
Neutral Protection			X	X
Electronic Contact Wear Indication			X	X
Temperature Indication			X	X
Incremental Fine Tuning of Settings			X	X
Selectable Long-time Delay Bands			X	X
Power Measurement			X	X
Waveform Capture				X
Data Logging				X

X=Standard o=Option

- .2 Main Fusible Switch
- .1 Shall be QMQB type fusible switch 400 through 1,200A, BOLT-LOC fixed mounted bolted pressure switch 1,600 through 3,000A.
- .2 Bolted pressure contacts shall be made by providing an additional

-
- pressure or clamping action at both ends of the switchblade when the blades are fully closed.
 - .3 Manual operated switches shall have quick-make, quick-break front operating mechanisms.
 - .4 Accessories shall be supplied as follows:
 - Capacitor trip power supply]
 - Blown main fuse indication
 - Phase failure relay with capacitor trip power supply
 - Key interlock
 - .5 Equipment ground fault protection
 - .1 Provide a zero-sequence type ground fault system including current sensor and appropriate relaying equipment. The current sensor shall enclose all phase (and neutral, if present) conductors to be monitored. The current sensor frame shall be so constructed that one leg can be opened to allow the removal of the sensor without disturbing the cables or requiring drop-links in the bussing. A test winding shall be provided to simulate the flow of ground fault current through the current sensor for testing.
 - .2 The ground fault relay shall be of solid state construction and have adjustable pick-up for ground fault currents from 100 amperes to 1200 amperes.

2.6 NOT USED.

2.7 Metering and Accessories

- .1 Main Metering
 - .1 Metering requirements that exceed the capabilities of the circuit breaker trip units shall use the Schneider Electric Powerlogic Circuit Monitor 4000T Powerlogic PM8244, Powerlogic PM5563, [Powerlogic ION7550 Powerlogic ION7650, Powerlogic ION8650
 - .2 CT's shall be appropriately sized for use on the main
 - .3 Separate HMI displays shall be mounted on Main breaker door
 - .4 Instrument compartment door
 - .5 Meter integrated communication available via Serial port or Ethernet port depending on meter type.

- .2 Communications
 - .1 Equipment can be selected with communications from among the following options
 - .1 Modbus RS48, without device Web pages
 - .2 Modbus RS48, with device Web pages
 - .3 Modbus RS485 to Ethernet Modbus TCP
 - .4 Direct Ethernet Modbus/TCP
 - .3 Energy Reduction Maintenance Setting Switch (ERMS)
 - .1 For each Main Tie or Feeder circuit breaker, provide a Maintenance OFF ON selector switch on the compartment door to switch the circuit breaker instantaneous tripping characteristics to an alternate setting temporarily during maintenance activity.
 - .2 Provide a lock feature for the ERMS switch so that it may be locked in either the OFF or ON maintenance mode position.
 - .3 Provide a blue LED indicating light to indicate trip unit is in the ERMS mode.
 - .4 Wire contacts on all ERMS switches to a common alarm input to plant control system.

2.8 GROUND FAULT PROTECTION

- .1 3-phase 4-wire, connected equipment having multiple sources shall have a modified differential ground fault system (MDGF). The manufacturer shall complete the MDGF design prior to building equipment to insure that the proper main or tie breaker (s) operate properly during the following occurrences on the main bus.
 - .1 Insure the system will trip with the occurrence of a ground fault at any location in the switchgear.
 - .2 Insure system will not trip without ground fault and with normal current flow.
 - .3 Insure system will not trip due to large single-phase currents.
 - .4 Insure system will trip with combination of normal current flow and ground fault current flowing together.
 - .5 Insure system will not trip with circulating currents through the neutral due to multiple grounds and sources external to the immediate low voltage power sources.
- .2 The manufacturer shall be required to include additional CT's, ground fault relays, interlocks, wiring, components etc. to insure the ground fault systems operates without nuisance tripping on the main bus of the switchgear.
- .3 The manufacturer shall include a wiring diagram of the MDGF system along with a test procedure using high current injection equipment.

2.9 DISTRIBUTION SECTION DEVICES

- .1 Group mounted circuit breakers through 100A to 1200A
 - .1 Breakers and all components shall be designed, manufactured and tested in accordance with applicable CSA standards.
 - .2 Circuit breaker(s) shall be rated for 80% continuous current.
 - .3 Circuit breakers(s) shall have 10kA, 14 kA, 18 kA, 25 kA 35 kA 42 kA 50 kA 65 kA interrupting capacity at 208Vac. Two tier CSA or UL listed series ratings are acceptable. When series ratings are applied with integral or

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- remote upstream devices, a label or manual shall be provided showing the CSA or UL approved series ratings including:
- Voltage
 - Size and type of upstream fuses or breakers
 - Size and type of branch devices that can be used
- .4 Circuit breaker(s) shall be group mounted plug-on with mechanical restraint on a common pan or rail assembly.
- .5 The interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.
- .6 Circuit breakers equipped with line terminal jaws shall not require additional external mounting hardware. Circuit breakers shall be held in mounted position by a self-contained bracket secured to the mounting pan by fasteners. Circuit breakers of different frame sizes shall be capable of being mounted across from each other.
- .7 Line-side circuit breaker connections are to be jaw type.
- .8 All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.
(Select Electronic trip 100%, Electronic trip 80% or Thermal Magnetic)
- .1 Electronic trip molded case full function 100% rated circuit breakers
- .1 All electronic circuit breakers shall have the following time/current response adjustments: Long Time Pickup, Long Time Delay, Short Time Pickup, Short Time Delay, Ground Fault Pickup Ground Fault Delay and Instantaneous settings. Each adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.
 - .2 Circuit breaker trip system shall be a microprocessor-based true RMS sensing designed with sensing accuracy through the thirteenth (13th) harmonic. Sensor ampere ratings shall be as indicated on the associated schedule/ drawing.
 - .3 Local visual trip indication for overload, short circuit and ground fault trip occurrences.

- .4 Long Time Pickup indication to signal when loading approaches or exceeds the adjustable ampere rating of the circuit breaker shall be provided.
- .5 Communications capabilities for remote monitoring of circuit breaker trip system, to include phase and ground fault currents, pre-trip alarm indication, switch settings, and trip history information shall be provided.
- .6 Circuit breaker shall be provided with Zone Selective Interlocking (ZSI) communications capabilities on the short-time and ground fault functions compatible with all other electronic trip circuit breakers and external ground fault sensing systems as noted on schedules/drawings.
- .7 Furnish thermal magnetic molded case circuit breakers for 250A frames and below.
- .2 Electronic trip molded case standard function 80% rated circuit breakers
 - .1 All electronic circuit breakers shall have the following time/current response adjustments: Long Time Pickup, Long Time Delay, Short Time Pickup, Short Time Delay, Ground Fault Pickup Ground Fault Delay and Instantaneous settings. Each adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.
 - .2 Circuit breaker trip system shall be a microprocessor-based true RMS sensing designed with sensing accuracy through the thirteenth (13th) harmonic. Sensor ampere ratings shall be as indicated on the associated schedule/drawing.
 - .3 Local visual trip indication for overload, short circuit and ground fault trip occurrences.
 - .4 Long Time Pickup indication to signal when loading approaches or exceeds the adjustable ampere rating of the circuit breaker shall be provided.
 - .5 Furnish thermal magnetic molded case circuit breakers for 250A frames and below.
- .3 Thermal magnetic molded case circuit breakers
 - .1 Molded case circuit breakers shall have integral thermal and instantaneous magnetic trip in each pole.
 - .2 Circuit protective devices shall be Square D molded case circuit breakers. Circuit breakers shall have 10kA, 14kA 18kA, 25kA. 35kA. 50kA. 65kA. True current limiting* interrupting capacity at 208Vac. Ampere ratings shall be as shown on the drawings.
* Manufacturer shall submit one set of published I_p and I^2t let-through curves (as required by CSA or UL) to the owner.

3. Execution

3.1 INSTALLATION

- .1 Install switchboards in accordance with manufacturer's written instructions, and applicable standards and safety codes.

3.2 FIELD QUALITY CONTROL

- .1 Inspect complete installation for physical damage, proper alignment, anchorage, and grounding.
- .2 Measure steady state load currents at each switchboard feeder; rearrange circuits in the switchboard to balance the phase loads within 20% of each other. Maintain proper phasing for multi-wire branch circuits.
- .3 Check tightness of bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written specifications.

END OF SECTION

1. General

1.1 DESCRIPTION

- .1 Provide molded case circuit breaker switches and panelboards type CDP for 120/208 volt distribution as indicated on the drawings. Approved manufacturer Schneider to maintain series rating with main distribution. Integrated equipment rated with upstream protective devices.

2. Products

2.1 MOULDED CASE CIRCUIT BREAKER

- .1 Rating: voltage and ampere ratings as shown, 3 pole unless shown otherwise.
- .2 Construction: Equipped with thermal time delay trip, magnetic instantaneous trip, overcentre toggle mechanism, silver alloy contacts, high contact pressure, common trip for 2 or 3 pole, air chute arc extinguishers, three position handle,
- .3 Frame Sizes: Schneider frame sizes shown on the drawings and indicate standard or hard case. In all cases, breakers shall be of a type completely protected by the upstream breakers used in the feeder to the panelboard.
- .4 Connectors: Solderless pressure lugs, sized for cables, bolt-on bus connections.
- .5 Special Features: Where indicated on the drawings, provide special features, such as shunt trips for remote operation, keyed interlocks, non-auto, solid

2.2 INDIVIDUAL MOUNTED MOULDED CASE CIRCUIT BREAKER

- .1 Breaker Switches:
 - .1 Enclosures: CSA Code gauge galvanized steel, hinged door, front mounted external operating handle, lockable in "OFF" position, EEMAC-1 unless shown otherwise. Exterior breakers and switches showed WP on drawings to have EEMAC-12 enclosures. Increase enclosure size above standard for large cables.
 - .2 Neutral Bars: Where distribution system has grounded neutral conductor, provide neutral bar, with ampere rating equal to switch rating, in enclosure.

2.3 CDP PANELBOARDS

- .1 Construction: To CSA Standards, apply CSA approval labels.
- .2 Voltage and ampere ratings as shown, 3 phase, 4 wire solid neutral for 4 wire distribution system.
- .3 Tubs: CSA code gauge galvanized steel, braced to support interiors, 102 mm x 32 mm support channels full width front and back on floor mounted.
- .4 Mains: Copper bus ampere rating as shown on the drawings, braced to minimum 42 KA unless shown otherwise on the drawings. Minimum bracing to I.C. of noted breakers.
- .5 Neutral Bus: Provide neutral bus with ampere rating equal to the panelboard mains for all distribution systems with grounded neutral conductor connections. Provide ground bars to panels as noted.

- .6 Breaker Arrangement: As shown on the drawings. Minor changes permitted to suit manufacturer.
- .7 Front Covers, Doors: CSA code gauge galvanized steel; fronts to cover wiring gutter space between breakers and tub sides, same size as tubs and flush with sides; with steel trim attached to back of covers to close space between covers and breakers; doors with concealed hinges, combination locks and latches, to
- .8 Finish: One primer coat and one finish coat on all metal surfaces and doors.
- .9 Panelboards in Switchboards: Modify enclosure construction to suit switchboard.
- .10 Breaker Spaces: Provide spaces for future breakers with ampere ratings and frame sizes as shown. Allow at least 40% space.
- .11 Special Features: Provide drip hoods, non-ferrous entry plates and other special features as shown on the drawings.
- .12 Main Breakers: Three pole, molded case circuit breakers, ampere sizes and frame sizes as shown.
- .13 CU/AL rated.

3. Execution

3.1 INDIVIDUAL MOUNTED MOULDED CASE CIRCUIT BREAKER

- .1 Mounting: Provide supports independent of conduits. Wall mount where possible, otherwise provide steel angle frame supports. Where switches are grouped, mount in uniform arrangement.
- .2 Wiring: Connect line and load cables to all switches.
- .3 Identification: Provide lamacoid plate on each switch showing voltage, phases and wires, source of supply and load being fed -

Voltage, phases and wire e.g. 120/208, 3 phase, 4
wire Fed from MDP No. 1
To Panel A

3.2 CDP PANELBOARDS

- .1 Mounting: Provide supports independent of conduits, mount as shown on the drawings. Bolt floor mounted panelboards to floor.
- .2 Wiring: Connect supply and all branch circuit breakers. Install branch breaker cables in neat bundles at sides of cable gutters. Install cables to branch circuit breakers horizontally.
- .3 Identification: Provide lamicoid plate on each panelboard cover showing panelboard designation, voltage and source of feed -

Panelboard "A"
Voltage, phases and wires e.g. 120/208V, 3 phase, 4
wire Fed from CDP "B"

- .4 Identify each branch circuit breaker with a lamicoid plate to show load
being fed - To Panel "PPA"

END OF SECTION

1. General

1.1 DESCRIPTION

- .1 Provide panelboards for 120/208 volt branch circuit distribution as indicated on schedules shown on the drawings, complete with all items listed.
- .2 Construct panelboards to CSA Standards, apply CSA approval labels.
- .3 Panelboards to be manufactured by Schneider.
- .4 Supply shop drawings on all panelboards, switchboards and CDP's.

2. Products

2.1 MATERIALS

- .1 Tub: CSA code gauge galvanized steel, reversible top and bottom, finish painted ANSI 61 grey enamel or as specified in Section 26 05 01.
- .2 Mains: Copper, ampere ratings as shown, solderless lug connectors sized for cables in panels without main breakers, bolt-on connectors for all main breakers and branch circuit breakers.
- .3 Neutral Bars: Same ampere ratings as mains, solderless lugs for connections.
- .4 Front shields to cover breaker assembly and neutral bars, leaving wiring gutters accessible when fronts removed.
- .5 Front Covers, Doors: CSA code gauge galvanized steel, with doors, concealed hinges, combination locks and latches, interior plastic covered circuit directory cardholders, concealed mounting screws, finish painted, same size as tubs where surface mounted, overlapping trim with wall gaskets where flush
- .6 Locks, Keys: All locks keyed alike.
- .7 Branch Circuit Breakers: Thermal magnetic with "ON", "OFF" and "TRIPPED" positions, single, two and three pole as shown; ampere ratings as shown; bolt-on line connections, solderless lug load connections; common trip for two and three pole; rated 240 volt 10,000 amps symmetrical short circuit interrupting capacity in 120/208 volt (Unless noted otherwise on single line drawing.) Breakers to be integrated equipment rated with upstream protective devices.
- .8 Spaces: Stamp out spaces, install removable fillers where breaker spaces are required.
- .9 Ground Fault Circuit Interrupters: Breakers having both 5 ma ground fault sensitivity and over current protection, of the amperage rating indicated, shall be installed in the panelboards where required. Wire each ground fault breaker with a separate neutral conductor wired through the interrupter to the ground
- .10 CU/AL Rated.

3. Execution

3.1 MOUNTING

- .1 Provide supports independent of conduits. Match trim and door heights on adjacent panelboards. Coordinate mounting heights with fire hose cabinets and other equipment as instructed by the A/E.

3.2 WIRING

- .1 Install branch circuit wiring in neat bundles at sides of wiring gutters, with wires to branch breakers horizontal.

3.3 IDENTIFICATION

- .1 Provide lamicoid plate securely and permanently attached to the exterior of each panelboard door showing panelboard designation, voltage and
- .2 For all ground fault breakers, provide a sign indicating that circuits are so protected and that equipment should be tested regularly.

3.4 BRANCH CIRCUIT DIRECTORY

- .1 Provide typed directory identifying all branch circuits. Directory to indicate device and location.

3.5 LOCKING STRAPS

- .1 Locking Straps: To permit automatic tripping of breakers but prevent manual switching, for exit lights, receptacles feeding emergency battery packs, data racks, security panels, UPS receptacles, and where designated.

3.6 KEYS

- .1 Provide 3 keys to Owner per panel.

3.7 CONDUIT STUBS

- .1 From each panelboard installed flush, provide 3 - 12 mm and 2 - 25 mm spare conduits from the panelboard tub to an accessible location in the ceiling space

END OF SECTION

1. General

1.1 RELATED WORK

- .1 Installation of anchor devices, Section 26 05 29 – Hangers, Supports and Inserts, channel base Cast-in-Place sills, setting Concrete templates.

1.2 REFERENCES

- .1 CAN/CSA-Q9000-92, Quality Management and Quality Assurance Standards - Guidelines for Selection and Use.

1.3 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 26 05 01 – Electrical General Requirements.
- .2 Indicate:
 - .1 Outline dimensions
 - .2 Configuration of identified compartments.
 - .3 Floor anchoring method and dimensioned foundation template.
 - .4 Cable entry and exit locations.
 - .5 Dimensioned position and size of busbars and details of provision for future extension.
 - .6 Schematic and wiring diagrams.

1.4 OPERATION AND MAINTENANCE DATA

- .1 Provide operation and maintenance data for motor control centre for incorporation into manual specified in Section 26 05 01 – Electrical General Requirements.
- .2 Include data for each type and style of starter.

1.5 SOURCE QUALITY CONTROL

- .1 Provide manufacturer's type test certificates including short circuit fault damage certification up to short circuit values specified under bus bracing.
- .2 Owner to witness standard factory testing of complete motor control centre including operation of switches, circuit breakers, starters and controls.
- .3 Manufacturer to provide proof of quality control program in accordance with CAN/CSA- Q9000.

2. Products

2.1 SUPPLY CHARACTERISTICS

- .1 600 V as indicated on the drawings, 60 Hz, Y connected, 3 phase, 3 wire, grounded.

2.2 GENERAL DESCRIPTION

- .1 Compartmentalized vertical sections with common power busbars.
- .2 Floor mounting, free standing, enclosed dead front.

- .3 Indoor CSA 2 enclosure, front mounting.
- .4 Class I Type A.

2.3 VERTICAL SECTION CONSTRUCTION

- .1 Independent vertical sections fabricated from rolled flat steel sheets bolted together to form rigid, completely enclosed assembly.
- .2 Each vertical section divided into compartment units, minimum 305 mm high, as indicated.
- .3 Each unit to have complete top and bottom steel plate for isolation between units.
- .4 Horizontal wireways, equipped with cable supports, across top and bottom, extending full width of motor control centre, isolated from busbars by steel
- .5 Vertical wireways c/w doors for load and control conductors extending full height of vertical sections and equipped with cable tie supports. Installation wiring to units accessible with doors open and units in place
- .6 Openings, with removable coverplates, in side of vertical sections for horizontal wiring between sections.
- .7 Incoming cables to enter at top with terminals as indicated.
- .8 Provision for outgoing cables to exit via top or bottom with terminals.
- .9 Removable lifting means.
- .10 Provision for future extension of both ends of motor control centre including busbars without need for further drilling, cutting or preparation in field.
- .11 Divide assembly for shipment to site, as indicated complete with hardware and instructions for re-assembly.

2.4 SILLS

- .1 Continuous 76 mm channel iron floor sills for mounting bases with 19 mm diameter holes for bolts.

2.5 BUSBARS

- .1 Main horizontal and branch vertical, three phase high conductivity solid copper busbars in separate compartment bare self-cooled, extending entire width and height of motor control centre, supported on insulators and rated:
 - .1 Main horizontal busbars: 600 A.
 - .2 Branch vertical busbars: 300 A.
- .2 Branch vertical busbars for distribution of power to units in vertical sections.
- .3 No other cables, wires, equipment in main and branch busbar compartments.
- .4 Brace buswork to withstand effects of short-circuit current of 42 kA rms symmetrical or as indicated by the fault study.

- .5 Bus supports: with high dielectric strength, low moisture absorption, high impact material and long creepage surface designed to discourage collection of dust.

2.6 GROUND BUS

- .1 Copper ground bus extending entire width of motor control centre.
- .2 Vertical ground bus strap, full height of section, tied to horizontal ground bus, engaged by plug-in unit ground stab.

2.7 STARTER UNIT COMPARTMENTS

- .1 Units EEMAC size 5 and smaller, circuit breaker units 225 A and smaller, plug-in type with self-disconnect. Guide rail supports for units to ensure that stabs make positive contact with vertical bus. Provision for units to be installed or removed, off load, while buses energized.
- .2 Unit mounting:
 - .1 Engaged position - unit stabbed into vertical bus.
 - .2 Withdrawn position - unit isolated from vertical bus but supported by structure. Terminal block accessible for electrical testing of starter.
 - .3 Provision for positive latching in either engaged or withdrawn position and padlocking in withdrawn position.
 - .4 Stab-on connectors free floating tin plated clips, self-aligning, backed up with steel springs.
- .3 External operating handle of circuit switch interlocked with door to prevent door opening with switch in "on" position. Provision for 3 padlocks to lock operating handle in "off" position and lock door closed.
- .4 Hinge unit doors on same side.
- .5 Overload relays manually reset from front with door closed.
- .6 Pushbuttons and indicating lights mounted on door front.
- .7 Devices and components by one manufacturer to facilitate maintenance.
- .8 Pull-apart terminal blocks for power and control to allow removal of starter units without removal of field wiring.
- .9 Provide single phase protection for all three phase motors either by relaying, differential overloads, or EMCS shutdown.

2.8 WIRING IDENTIFICATION

- .1 Provide wiring identification in accordance with Section 26 05 53 - Electrical General Requirements.

2.9 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 01 - Electrical General Requirements.

- .1 Motor control centre main nameplate: engraved 1.
- .2 Individual compartment nameplates: engraved as indicated.

2.10 FINISHES

- .1 Apply finishes in accordance with Section 26 05 53 - Identification.
- .2 Paint motor control centre exterior light gray and interiors white.

2.11 ACCEPTABLE MANUFACTURERS

- .1 Schneider

3. Execution

3.1 INSTALLATION

- .1 Set and secure motor control centre in place on channel bases, rigid, plumb and square to building floor and wall.
- .2 Make field power and control connections as indicated.
- .3 Ensure correct overload heater elements are installed.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 01 26 – Testing, Adjusting and Balancing of Electrical Equipment and Systems.
- .2 Ensure moving and working parts are lubricated where required.
- .3 Operate starters in sequence to prove satisfactory performance of motor control centre during 8 h period.

END OF SECTION

1. General

1.1 RELATEDWORK

- | | | |
|----|---|------------------|
| .1 | Connections to Mechanical Equipment | Section 25 30 01 |
| .2 | Connections to Wiring Systems Installed | Section 26 27 11 |
| .3 | Motor Identification | Section 25 05 55 |

1.2 STARTER REQUIREMENTS

- .1 In general, there are three categories of starting equipment for three phase motors.
 - .1 Integral Mounted Starters: Some items of mechanical equipment such as boilers, have the starter mounted as part of the equipment. For this equipment, supply disconnects and wire to the terminals of the equipment.
 - .2 Separately Mounted Starters: For motors without integral mounted starters, supply separately mounted starters as indicated on the Drawings and wire the equipment.
- .2 Provide manual motor starters for all single phase motors unless otherwise indicated on the motor schedule.
- .3 Provide interlocking between starters where required.
- .4 All starter accessories such as pilot lights, Hand-Off-Auto, Start-Stop, etc., whether integrally or remote mounted shall be heavy-duty oil tight, unless otherwise specified.
- .5 Review and coordinate all starter characteristics with specific motors. Ensure all two speed motor starters are compatible with motors supplied by Division 25.

1.3 CONTROLS

- .1 The work of this Division shall not include the wiring of HVAC controls, such as freeze stats, fire stats, E.P. and P.E. switches.

1.4 SHOPDRAWINGS

- .1 Obtain wiring diagrams and information from other trades on control systems. Coordinate and incorporate information on motor control centre shop drawings.
- .2 Prepare shop drawings and wiring diagrams for motor control centre under supervision of suitably qualified staff.
- .3 Consult with the A/E during preparation of shop drawings as required to ensure correct interpretation.

2. Products

2.1 MOTOR STARTERS GENERAL

- .1 Except where specifically noted otherwise, this Division shall supply and install all motor starters. Starters to be combination type with current limiters when indicated in new grouped 4 plex Motor Control.
- .2 Starters to IEC 292 or EEMAC standards. Interrupting capacity minimum 10 kA.

- .3 All individually mounted motor starters shall be enclosed in a general-purpose sheet steel enclosure unless in wet areas where they shall be watertight EEMAC 4.

2.2 MANUAL MOTOR STARTERS:

- .1 Where manual motor starters are indicated, provide manual motor starter switches with "ON" pilot lights, and overload protective devices, manual reset, trip indicating handle.
- .2 Starters to have quick make quick break toggle switch operation, rated volts, and poles, to suit application. Locking tab to permit locking in the "ON" of "OFF".

2.3 FULL VOLTAGE MAGNETIC STARTERS:

- .1 All three phase magnetic motor starters to be across-the-line magnetic starters, except as noted. Each FVNR starter shall contain within its enclosures:
 - .1 Contactor with three overload devices having either one form A and one form B contact, or an auxiliary relay. Overload trip contacts shall be wired to the line side of the contactor coil such that the neutral side of the coil is wired directly to the grounded circuit.
 - .2 A control transformer of sufficient VA capacity to provide 120 volt control complete with primary and secondary fuses for all ungrounded conductors installed with starter. Fuses to be English Electric "red spot" fuse fitting CCRS154. Size for load plus 20% sparer capacity.
 - .3 Two sets of auxiliary contacts (2NO and 2 NC) in addition to standard with provision to convert one set to normally closed.
 - .4 Red pilot light to indicate energized motor circuit and where called for green pilot light to indicate de-energized motor circuit. Pilot lights shall LED be push-to-test transformer type, heavy duty, oil tight.
 - .5 Thermistor control relay and accessories for all motors 22.4 kW and above.
 - .6 Starters for motors 5hp and larger shall have single phase protection.
- .2 All combination motor starters shall be of the circuit breaker type complete with HRC Form J fuses, unless otherwise indicated. Combination starters shall have external operating handle with lock off facilities, lock on position. Entry door shall be fitted with switch/door interlock devices.
- .3 Accessories as indicated except standard duty HOA, 2 N/O and 2 NC spare auxiliary contacts.
- .4 Supply and install overload heaters and one overload device on each phase.
- .5 Provide lamicoid nameplates with lettering as indicated. The equipment name and number shall be indicated. See "Identification" Section 26 05 01.
- .6 Switches shall not be accessible to unauthorized personnel, e.g. mount in service rooms.

3. Execution

3.1 STARTER VERIFICATION

- .1 Field check motor starters supplied prior to commissioning equipment. As a minimum, verify the following:
 - .1 Check of control circuits
 - .2 Verify that overload relay installed is correctly sized for motor sued.
 - .3 Record overload relay size and motor nameplate amperage

-
- .4 Visual inspection of fuses and contactors.
 - .5 Ensure all connections are tight.
 - .2 Measure and record motor amps, under load conditions and compare with full load amps and motor service factor. Report any excessive readings and unbalance. Measure voltage as close to motor terminals as possible while motor is running.
 - .3 Set all motor circuit protectors to the minimum level which will consistently allow the motor to start under normal starting conditions.
 - .4 Refer to Section 26 05 82 "Motor Identification".

3.2 OVERLOAD RELAYS

- .1 For starters provided, select overload relays in accordance with relay and motor manufacturers' recommendations, considering motor service factors, ambient temperature, temperature differences between motor and starter locations. Monitor motor operation during startup to ensure motor operation is satisfactory and relays provide proper protection. For side inlet fans and other long acceleration time motors, provide special overload relays to suite the start-up condition. Provide manufacturers' curves and data sheets where necessary to provide supporting data for motor protection.
- .2 Overload heaters when equipped with an adjustable dial setting to be set up to suit site conditions and motor characteristics.

END OF SECTION

1. General

1.1. SCOPE

- .1 The work under this section includes electronic meters including test switch and instrument transformers as specified herein and shown on the Drawings. Included are the following topics:

1.2. RELATED WORK

- .1 Applicable provisions of Division 1 govern work under this Section
- .2 Section 01 91 01 or 01 91 02 – Commissioning Process
- .3 Section 26 08 00 – Commissioning of Electrical
- .4 Section 26 24 13 – Switchboards
- .5 Section 26 24 16 – Panelboards

1.3. REFERENCES

- .1 ANSI C57.13 – Instrument Transformers

1.4. SUBMITTALS

- .1 Provide product data showing model numbers, dimensions, mounting requirements, and parameters measured and displayed.

1.5. OPERATION AND MAINTENANCE DATA

- .1 All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

2. Products

2.1. UTILITY METERING

- .1 Provide a stand-alone CT cabinet, or a separate utility metering section in the switchboard. Provide a meter socket with a 1-inch conduit to the CT cabinet. Coordinate approved manufacturer(s), style, and location of metering equipment with local utility requirements.

2.2. ELECTRONIC METER at MAIN ELECTRIC SERVICE (Non-Utility Metering)

- .1 Electronic meter with digital display (LED or LCD), shall accept input from standard current transformers rated 5 amperes. Meters for systems operating at 480V and below shall measure circuit potential without the use of external potential transformers. Meter shall be suitable for connection to a three-phase, four-wire wye system or a three-phase, three-wire delta system.
- .2 Meter accuracy shall be 0.5% of actual reading (not full-scale measurement).
- .3 Meter shall display actual numeric values without requiring the use of a multiplier. Meter shall measure and display the following:
 - .1 Current: per phase
 - .2 Voltage: phase-to-phase and phase-to-neutral
 - .3 Real Power (kW): three-phase total
 - .4 Reactive Power (kVAR): three-phase total
 - .5 Apparent Power (kVA): three-phase total
 - .6 Power Factor: three-phase
 - .7 Real Energy (kWh): three-phase total
 - .8 Maximum Demand

- .1 Real Power (kW): three-phase total
- .2 Apparent Power (kVA): three-phase total
- .4 All meter potential leads and control power leads shall be fuse protected. Provide a fused disconnecting device or circuit breaker with downstream fuses in the main switchboard or panelboard for protection of the meter potential leads and control power leads. Fuses shall be sized per manufacturer's recommendations.
- .5 Provide a Meter Interface Gateway device to convert the meter's Modbus RTU output (measured values listed above) to BACnet/IP for interface Building Automation System (BAS). Meter gateway device shall include a prebuilt template for the PQMII of the information. Gateway to be provided is: Real Time Automation – model RTA-460MX-S051. Consult with personnel for proper wiring and termination procedures and gateway software configuration.
- .6 The electrical contractor shall be responsible for providing all communication wiring between the meter and the interface gateway and shall provide Ethernet communication wiring from the interface gateway to the IT closet.
- .7 Building Automation System (BAS) data jacks will be installed according to the building standard except that a data jack is not needed, and a patch cord can be used between the utilizing equipment and the network switch port under the following exceptions:
 - .1 If the utilizing equipment is mounted on or within the vertical sides of the floor or wall rack.
 - .2 If the utilizing equipment is mounted within the same telecommunications room and can be reached with a 40 foot or shorter patch cord that is routed with existing cabling in the racks, trays, J-hooks, etc....and is not stretched tight.

NOTE: If a patch cord is used in exceptions A or B above, the patch cord must be labeled on each end listing the termination point on the opposite end.

EXAMPLE:

Switch name and port #.....to..... equipment name
s-weeks-156-1-access, port 22.....MS-SECVT0 north wall

[Provide a Meter Interface Gateway as described in the "Meter Interface Gateway" subsection of this specification.]

2.3. METER TEST SWITCH

- .1 Provide a 600 volt ten-pole (4 potential and 6 current shorting) test switch with cover, ABB Type FT-1, or approved equal, connected between each meter and the CT and potential leads. The six leads (2 per phase) from the CT's shall be connected to the current shorting terminal positions on the test switch. The four leads ((3) phase and (1) neutral) from the PT's or bus shall be connected to the potential terminal positions. The test switch shall be located on the face of the switchgear adjacent to the meter or behind a panel cover in an easily accessible location.
- .2 Meter test switch is required on all meter installations at switchboards and main distribution panels. Meter test switch is not required for sub-meters, or meters installed at branch panels, automatic transfer switches, and other downstream locations.

2.4. SUB-METER(S)

- .1 Electronic meter with digital display shall accept input from standard current transformers rated 5 amperes. Sub-meters may use 0-2V Current Sensors or 0-0.333V Current Transducers in lieu of Current Transformers. Meter shall be suitable for connection to a three-phase, four-wire wye system, a three-phase, three-wire delta system, or a 120/240V single-phase system. Meter specification is based on Electro Industries Shark 100 or equal.
- .2 Meter accuracy shall be 1.0% of actual reading (not full scale measurement).
- .3 Meter shall display actual numeric values without requiring the use of a multiplier. Meter shall measure and display the following:

- .1 Current: per phase
- .2 Voltage: phase-to-phase and phase-to-neutral
- .3 Real Power (kW): three-phase total
- .4 Reactive Power (kVAR): three-phase total
- .5 Apparent Power (kVA): three-phase total
- .6 Power Factor: three-phase
- .7 Real Energy (kWh): three-phase total
- .8 Maximum Demand:
 - .1 Real Power (kW): three-phase total
 - .2 Apparent Power (kVA): three-phase total

[Meters for dormitory suites [shall be provided with LCD displays.] [shall not be provided with displays.]]

[Provide Meter Interface Gateway per the paragraph included in this specification section.]

- .4 Provide additional fusible disconnect switch(es)/circuit breaker(s) and enclosures per the PROVISIONS FOR SUB-METERS paragraph included in this specification section.
- .5 MULTI-POINT SUB-METERING SYSTEM: Where multiple sub-meters are desired in a common location, the following multi-point sub-metering system may be used:
 - .1 The Unit shall consist of either of two circuit configurations: 8 multifunction electrical measuring points (meters) for 3 phase power systems or 24 multifunction electrical measuring points (meters) for single phase power systems. The Unit's meters shall perform to spec in harsh electrical applications in high and low voltage power systems.
 - .2 Meter accuracy shall be 1.0% of actual reading (not full scale measurement).
 - .3 The Unit shall have optional data-logging memory of up to 32MB. With data-logging, the Unit shall support:
 - .1 Two pre-configured Historical logs: Log 1 for trending Voltage and Frequency, Log 2 for trending Energy use over time.
 - .2 An Alarm/Limits log that records the state of the 16 limits that can be programmed for the meter
 - .3 A System Events log to store events that happen in, or to the meter, including Startup, Reset commands, Log retrievals, and attempts to log on with a password.An I/O Change log to record changes in the inputs and outputs of the Relay Output/Status Input board.
 - .4 The Unit's meters shall be traceable revenue meters. The Unit which shall contain utility grade test pulses allowing power providers to verify and confirm that the meters are performing to their rated accuracy
 - .5 The Unit shall offer the following communication ports
 - 1. Com 1 shall support RS485 and optional RJ45 Ethernet/802.11b Wi-Fi. It shall support Modbus RTU, Modbus ASCII, and Modbus TCP; and baud rates from 9,600 to 57,600.
 - 2. Com 2 shall be a USB Serial port. It shall support Modbus ASCII and a baud rate of 57,600.
 - 3. Com 3 shall support RS485. It shall support Modbus RTU and Modbus ASCII; and baud rates from 9,600 to 57,600.
 - .6 The Unit shall have a Relay Output/Status Input board.
 - 1. The board shall have 2 Relay Outputs for control applications. The relay outputs shall be able to be triggered by the user-programmed limits in the meters. The user shall be able to assign up to 16 limits, including below-and above-limit conditions for any value the meter measures.

2. The board shall have 4 KYZ Counting Inputs. The KYZ inputs shall be able to be configured to count pulses from gas, water, condensate, and other commodity measuring devices.
- .7 The Unit shall consist of an all-metal enclosure and shall have the following physical properties:
 1. The Unit shall be able to be mounted within an electrical panel.
 2. The Unit shall have a stud-base connection for current inputs

2.5. METER INTERFACE GATEWAY

- .1 Provide a meter interface gateway to allow the meter(s) (daisy-chained to a single interface location) to communicate with the BAS system protocol listed below. The interface gateway shall convert the meter data from the meter's native language to the BAS protocol.
- .2 If the meters can communicate with the BAS system without the use of an interface gateway, then no gateway is required.
- .3 Existing Building Automation System (BAS) communication protocol:

- .1 BACnet/IP. Meters that have internal BACnet/IP communication interface: Electro Industries Shark 100B series or equal.

[The Main Electric Service meter] [and all Sub-meters] shall have a BACnet/IP interface (either on-board or a separate gateway) to the BAS system.

The Division 26 electrical contractor shall be responsible for providing all communication wiring between the meters, between the meters and the interface gateway, and between the gateway and the telecom switch. Coordinate with the facility IT staff.

- .2 BACnet/MSTP. Meters that have internal BACnet/MSTP communication interface: Veris H8163 series, Delta Controls DSM-PWR, or equal. For delta three phase feeders without a neutral leg, the Veris H8163 cannot be used.

[The Main Electric Service meter] [and all Sub-meters] shall have a BACnet/MSTP interface (either on-board or a separate gateway) to the BAS system.

The Division 23 Controls contractor shall be responsible for providing all communication wiring between the meters, between the meters and the interface gateway, and between the gateway and the BAS system. Coordinate with HVAC controls.

- .4 Manufacturers of gateway devices that can provide a BACnet interface for electrical meters with other native protocols: Industrial Control Communications, Inc. - Millennium Gateway Series, Real Time Automation – 460 Series, Delta Controls DSM-PWR, FieldServer, Tridium, or Johnson Controls. All programming of the gateway device to provide the BACnet objects to the building automation system shall be included
- .5 The interface gateway shall transmit all of the measured values listed under the meter descriptions in this specification section.

2.6. PROVISIONS FOR SUB-METERS

- .1 OVERCURRENT PROTECTION FOR POTENTIAL LEADS AND CONTROL POWER LEADS: If the sub-meter(s) are located in the main switchboard, provide a fusible disconnect or circuit breaker in the metering section of the switchboard for the protection of the potential transformers or potential leads as required for the sub-meter(s). If the sub-meter(s) are located adjacent to a panelboard, then the contractor must provide a 3-pole

15 amp circuit breaker in that panelboard as required for the potential transformers or potential leads for the sub-meter(s).

- .2 All meter potential leads and control power leads shall be fuse protected. Provide fuses in the disconnecting device or downstream fuses from the circuit breaker for protection of the meter potential leads and control power leads. Fuses shall be sized per manufacturer's recommendations.

- .3 **ENCLOSURE(S)**

- .1 If the sub-meters are located adjacent to the switchboard or panelboard, then:
The meters shall be provided in a common meter enclosure.

The meters shall be capable of being mounted in a common enclosure when there is more than one (1) meter.

The metering enclosure shall be provided with separate wiring troughs for line voltage and low voltage wiring.

The enclosure shall come equipped with a control power transformer.

The enclosure shall come with voltage fuses and a shorting block for use with current transformers.

The enclosure shall have a lockable door.

2.7. ACCESSORIES

- .1 Provide shorting block(s) for the CT leads.

2.8. CURRENT TRANSFORMERS

- .1 Current Transformers: ANSI C57.13; 5 ampere secondary, with primary/secondary ratio as shown on Drawings, burden and accuracy consistent with connected metering and relay devices, 60 Hz.
 - .2 Sub-meters may use 0-2V Current Sensors or 0-0.333V Current Transducers In lieu of Current Transformers.
 - .3 Mount and brace transformers to withstand 100,000 amp short circuit current.

2.9. POTENTIAL TRANSFORMERS

- .1 Provide potential transformers (PT's) only if required by the meter manufacturer. Most meters can measure 480V potential and below without the use of external PT's.
 - .2 Potential Transformers: ANSI C57.13; 120 volt secondary, burden and accuracy consistent with connected metering and relay devices, 60 Hz.
 - .3 Potential transformers on 480/277 volt systems shall be rated 277 – 120 volts, connected phase-to-neutral, and installed on each phase.

3. Execution

3.1. INSTALLATION

- .1 The meters shall be mounted in the locations indicated on the drawings. Mounting height shall be 5'-6" or less from finished floor.
 - .2 New meters installed in existing equipment:
 - .1 All unused openings shall be covered with a metal closure plate painted to match the existing enclosure.
 - .2 Any extension of wiring needed to accommodate the meters shall be done using terminal blocks and #10 AWG stranded copper wire, 600 volt type SIS insulation.

Splices are not allowed

- .3 Provide a separate enclosure for the new meter if adequate space is not available in the existing panels.
- .4 Dangerous voltage will develop in the open circuit secondary windings of energized current transformers. De-energize the current transformers by short circuiting the secondary windings before disconnecting or connecting instruments to current transformers
- .5 Verify the proper operation of all meters. Compare the meter display readings to measurements taken with a clamp on amp-meter and hand held volt meter.
- .6 Provide all programming and field set-up of the meters required for measurement and communication of the electrical data.

3.2. CONSTRUCTION VERIFICATION

- .1 Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 26 08 00 in accordance with the procedures defined for construction verification in Section 01 91 01 or 01 91 02.

3.3. AGENCY TRAINING

- .1 All training provided for agency shall comply with the format, general content requirements and submission guidelines specified under Section 01 91 01 or 01 91 02.

END OF SECTION

1. General

1.1 SYSTEM

- .1 Conduit and outlets to form empty raceway system as indicated on the drawings.

2. Products

2.1 COMPONENTS

- .1 Conduit: Refer to Section 26 05 33.
- .2 Wall Outlet Boxes: Receptacle, blank coverplates and outlets as shown.
- .3 Wire Mold: Legrand G4000 series where shown.

3. Execution

3.1 GENERAL

- .1 Supply and install pullwire in all empty conduits.
- .2 Minimum conduit size 21mm.
- .3 Provide bushings on all conduits stubbed onto ceiling space.
- .4 Mount bottom of data outlets at 304 mm above finished floor or as noted drawings.
- .5 Junction boxes for outlets to be flush mounted in wall. Appropriate extension rings are to be provided where outlets are to be installed in millwork, backboards, chalkboards, etc.

END OF SECTION

1. General

1.1 WORK INCLUDED

- .1 Provide and connect all wiring devices for the complete installation.

2. Products

2.1 MANUFACTURER

- .1 Wiring devices to be of one manufacture throughout project unless noted.
- .2 Manufacturers shall be Acuity, Leviton, and Hubbell or approved equals.
- .3 Manufacturers shall be Leviton Decora style white for all key switches or approved equals. Provide a minimum of thirty (30) keys. Toggle switches not allowed.

2.2 DEVICES

- .1 The catalogue numbers shown below are for the particular manufacturer's series and all necessary suffixes shall be added for the requirements as stated. All devices shall be specification grade minimum and wherever possible shall be of the same manufacture.
- .2 Devices to be white with High Impact Smooth Nylon coverplates in all but mechanical areas unless noted otherwise. Use galvanized steel coverplates in mechanical areas and for surface mounted devices.

2.3 SWITCHES

- .1 Switches to be Leviton Decora white
- .2 120 volt, 15 amp, single and double pole, three and four-way: Leviton Decora series white
- .3 For wet locations use the following switches: 20A, 120V single pole white, side wired press-switch, as Leviton Decora series
- Leviton Universal dimmer DSL06-450W Led white
- Leviton Decora rocker slide control white
- Leviton ATE04-1L, ATE06-1L, ATE06-1L, IPE04-1L2, VPE04-1L, VPE04-1L, VPE06-1L
- .4 Do not gang Dimmer switches. Derate per manufacturer recommendation if ganged.

2.4 RECEPTACLES

- .1 Receptacles to be CSA C22.2 No. 42-M1984, duplex, 15A, 125 volt, U-ground.
- .2 Duplex 15 ampere, 120 volt, 3 wire, white, U-ground, as Leviton series.
- .3 Duplex 15 ampere, 120 volt, 3 wire, white, U-ground ground fault receptacle, Leviton series
- .4 Single 15 ampere 250 volt, 3 wire receptacle white with High Impact Smooth Nylon, as Leviton series.
- .5 Duplex 20 ampere, 125 volt, 3 wire, white, U-ground as Leviton NEMA 5-20R for standard outlet or equal.

- .6 Use single 5.20RA (T-slot) 20A duplex receptacle where indicated Leviton series white..

2.5 COVERPLATES

- .1 Provide coverplates for all wiring devices, including but not limited to telephone, computer, television.
- .2 Use sheet steel utility box cover for wiring devices installed in surface mounted utility boxes.
- .3 Use High Impact Smooth Nylon coverplates on all wiring devices mounted in flush-mounted outlet boxes unless otherwise specified including receptacles and light switches.
- .4 Weatherproof coverplates shall be as Leviton series for flush mounting and/or surface mounted. Must be Weatherproof in use to comply with CEC.
- .5 Use gasketed DS covers on FS and FD type boxes.

2.6 SPECIAL WIRING DEVICES

- .1 Class "A" ground fault circuit interrupter receptacles, similar to above, complete with zero sequence transformer , trip on 5 mA leakage current with provision for test and reset. 15A and 20A T-Slot.
- .2 Duplex 15 ampere, surge suppression receptacle as Hubbell No. 5262S. These outlets are required in all data communications rooms and rooms with more than ten computers (if the circuit is not from a SPD protected panel).
- .3 Twist Lock receptacles: where indicated and for theatrical lighting power bars.

3. Execution

3.1 INSTALLATION

- .1 Duplex receptacles used with data to be mounted at 787 mm to centre.
- .2 Install wall switches 48 inches (1200 mm) inches above floor, OFF position down.
- .3 Install switches vertically in gang type outlet box when more than one switch is required in one location.
- .4 Mount switches on the latch side of the doorway as close as possible to door frame unless otherwise indicated on drawings.

-
- .1 Install receptacles vertically in gang type outlet box when more than one receptacle is required in one location.
 - .2 Protect cover plate finish with paper or plastic film until all painting and other work is finished, then remove paper.
 - .3 Install suitable common coverplates where wiring devices are grouped. Do not distort plates by tightening screws excessively.
 - .4 Do not use coverplates meant for flush outlet boxes on surface mounted boxes.
 - .5 Wherever possible, mount equipment in a straight line at a uniform mounting height, coordinated with other equipment and materials.
 - .6 Mounting dimensions are to the centre of the devices. Final instructions on mounting heights shall be given by the A/E's representative at the site. The above shall be used as a guide, but shall be subject to final verification prior to installation.
 - .7 Supply and install a separate neutral conductor from branch circuit panel to devices for all dimmer control circuits.
 - .8 All wiring devices to be white in color.
 - .9 Drill opening for poke through fitting installation in accordance with manufacturer's instructions.
 - .10 Provide weatherproof, gasketed cover plates on flush mounted devices where shown, type and configuration to suit flush device and its orientation.
 - .11 Install blank and device cover plates on switches, receptacles and boxes.
 - .12 Provide GFCI protected 20Ampere receptacles in accordance with NEC - "Ground Fault Protection for Personnel" in bathrooms, garages, and receptacles mounted outside, and within 6 feet (1.8 m) of sinks in kitchen areas.
 - .13 All GFCI receptacles in wet areas shall be in weatherproof enclosure.
 - .14 In addition, GFI protection shall be provided for:
 1. Electrical receptacles within 6 feet (1.8 m) of the sinks or developing tanks in Dark rooms, and within 6 feet (1.8 m) of chemical bath tanks in electrolysis areas.
 2. Laboratory receptacles within 6 feet (1.8 m) of the sink, including sinks inside fume hood enclosures.
 3. Out-door electrical receptacles with weatherproof enclosure/protection.
 4. Receptacles within six feet of an emergency eye wash/shower.
 5. Receptacle feeding water cooler units and drinking fountains
 - .15 Permanently and effectively ground wiring devices in accordance with Division 26 Section "Secondary Grounding for Electrical Systems".

END OF SECTION

1. General

1.1 RELATED DOCUMENTS

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- .1 Section Includes:
 - .1 Cartridge fuses rated 600-V ac and less for use in enclosed switches and enclosed controllers.
 - .2 Spare-fuse cabinets.

1.3 SUBMITTALS

- .1 Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
 - .1 Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - .2 Current-limitation curves for fuses with current-limiting characteristics.
 - .3 Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
 - .4 Coordination charts and tables and related data.
- .2 Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - .1 Ambient temperature adjustment information.
 - .2 Current-limitation curves for fuses with current-limiting characteristics.
 - .3 Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
 - .4 Coordination charts and tables and related data.

1.4 QUALITY ASSURANCE

- .1 Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- .2 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- .3 Comply with NEMA FU 1 for cartridge fuses.
- .4 Comply with NFPA 70.

1.5 COORDINATION

- .1 Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.6 EXTRA MATERIALS

- .1 Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- .2 Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than

three of each size and type.

2. Products

2.1 MANUFACTURERS

- .1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - .1 Cooper Bussmann, Inc.
 - .2 Ferraz Shawmut, Inc.
 - .3 Littelfuse, Inc.

2.2 CARTRIDGE FUSES

- .1 Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

3. Execution

3.1 EXAMINATION

- .1 Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- .2 Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- .3 Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- .4 Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- .5 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- .1 Cartridge Fuses:
 - .1 Service Entrance: Class RK1, time delay.
 - .2 Feeders: Class RK1, time delay.
 - .3 Motor Branch Circuits: Class RK1, time delay.
 - .4 Other Branch Circuits: Class RK1, time delay.
 - .5 Control Circuits: Class CC, fast acting.

3.3 INSTALLATION

- .1 Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

- .1 Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

1. General

1.1 SUMMARY

- .1 Related Documents:
 - .1 Drawings and general provisions of the Subcontract apply to this Section.
 - .2 Review these documents for coordination with additional requirements and information that apply to work under this Section.
- .2 Section Includes:
 - .1 Enclosed molded case circuit breakers.
- .3 Related Sections:
 - .1 Division 01 Section "General Requirements."
 - .2 Division 01 Section "Special Procedures."
 - .3 Division 01 Section "Common Work Results for Electrical".
 - .4 Division 26 Section "Secondary Grounding for Electrical Systems".

1.2 REFERENCES

- .1 General:
 - .1 The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
 - .2 Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.
 - .3 Refer to Division 01 Section "General Requirements" for the list of applicable regulatory requirements.
 - .4 Refer to Division 26 Section "Common Results for Electrical" for codes and standards, and other general requirements.
- .2 ANSI/NFPA 70 - National Electrical Code.
- .3 NFPA – National Fire Protection Association:
 - .1 Standard for Electrical Safety in the Workplace (NFPA 70E & Worksafe BC)
- .4 NEMA – National Electrical Manufacturers Association:
 - .1 NEMA 250 Enclosures for Electrical Equipment
 - .2 NEMA AB1 Molded Case Circuit Breakers
- .5 UL – Underwriters' Laboratories:
 - .1 UL 489 Molded Case Circuit Breakers and Enclosures.

1.3 SUBMITTALS

- .1 Submit under provisions of Division 26 Section "Common Results for Electrical - Review of Materials" and Division 01 Section "General Requirements."
- .2 Submit five (5) copies of Product Data and Shop Drawings for equipment and component devices. Include time–current curves of circuit breaker trip units.
 - .1 Include dimensional outline drawings; conduit entrance locations and requirements; voltage rating, continuous and short-circuit current ratings; cable terminal sizes and temperature ratings.

- .3 Operation and Maintenance Data:
 - .1 Maintenance Data: Furnish five (5) copies of recommended maintenance procedures and intervals. Include spare parts data listing; source and current prices of replacement parts and supplies.
 - .2 2. Furnish Time–Current curves of circuit breaker trip units. Time–Current curves shall be first generation originals on full size 11 by 17 inches (280 by 432 mm) paper.

1.4 QUALITY ASSURANCE

- .1 Products shall be tested, approved and labeled/listed by Underwriters Laboratories, Inc., or by a nationally recognized testing laboratory (NRTL) as listed in Division 26 Specification "Common Work Results for Electrical."
- .2 Electrical equipment and materials shall be new and within one year of manufacture, complying with the latest codes and standards. No used, re-built, refurbished and/or re-manufactured electrical equipment and materials shall be furnished on this project.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver materials to site in unopened cartons or bundles as appropriate, clearly identified with manufacturer's name, Underwriter's or other approved label, grade or identifying number.
- .2 Handle in accordance with manufacturer's written instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

2. Products

2.1 MANUFACTURERS

- .1 Schneider
- .2 Eaton
- .3 Cutler-Hammer.
- .4 Siemens

2.2 MOLDED CASE PROTECTIVE DEVICES

- .1 Protective devices shall be molded case circuit breakers with inverse time and instantaneous tripping characteristics
- .2 Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be non-welding silver alloy and arc extinction shall be accomplished by means of arc chutes.
- .3 Circuit breakers shall have a minimum symmetrical interrupting capacity as indicated on the drawings.
- .4 Circuit breakers 15 to 100 ampere frame shall be provided with fixed thermal-magnetic trip units.
- .5 Circuit breakers 225 ampere frame and above shall be provided with field-changeable, field-adjustable thermal-magnetic trip units with inverse time-current characteristics. Trip mechanisms shall be provided with the following trips: [instantaneous] [long time] [short time].
- .6 Circuit breakers 400 ampere frame and above shall be provided with microprocessor-based RMS sensing trip units with features noted on the drawings. Trip mechanisms shall be provided with the following trips: [instantaneous] [long time pickup] [long time delay]

- [short time pickup] [short time delay] [I2t function] [ground fault pickup] [ground fault delay].
- .7 Circuit breakers for HVAC and refrigeration unit equipment shall be listed by UL as Type HCAR.

2.3 ACCESSORIES

- .1 Provide accessories as indicated on the Drawings.
- .2 Shunt Trip Device: Coil rated for 120/208 volts, AC.
- .3 Undervoltage Trip Device: Coil rated for 120 /208 volts, AC.
- .4 Auxiliary Contacts: Rated at 120/ 208 volts, AC, see dwg. for rating. Contacts on an auxiliary switch; operation is designated "a" if open when the main circuit breaker contacts are open and "b" if closed when the main circuit breaker contacts are closed.
- .5 Alarm Switch: Rated at 120/ 208 volts, AC, see dwg. for rating. Alarm switch shall operate upon the tripping of the circuit breaker. Contacts on an auxiliary switch; operation is designated "a" if open when the main circuit breaker contacts are open and "b" if closed when the main circuit breaker contacts are closed.
- .6 Auxiliary Switch: Rated at 120/ 208 volts, AC, see dwg. for rating. Switch shall be interlocked with the main circuit breaker contacts.
- .7 Electrical Operator: Rated for 120/ 208 volts, AC.
- .8 Neutral Bus, insulated from enclosure: See drawings for Ampere rating.

2.4 ENCLOSURES

- .1 Provide enclosures fabricated from [steel] [aluminum] [plastic] suitable for locations as indicated on the drawings and as described below:
- .1 NEMA 1 surface or flush-mounted general purpose enclosures intended for indoor use.
- .2 NEMA 12 dust-tight enclosures intended for indoor use to provide protection against circulating dust, falling dirt and dripping non-corrosive liquids.
- .3 NEMA 3R rain-tight enclosures intended for outdoor use in damp locations or to provide protection against rain.
- .4 NEMA 4/4X watertight stainless steel intended for indoor or outdoor use to provide protection against windblown dust and rain, splashing rain, hose-directed water, and damage from corrosive agents
- .5 NEMA 7, Class I, Group C and D hazardous location cast aluminum intended for indoor use in locations classified as Class I, Group C and D as defined in the National Electrical Code
- .6 NEMA 9, Class II, Groups E, F and G hazardous location cast aluminum intended for indoor use in locations classified as Class II, Groups E, F and G as defined in the National Electrical Code
- .2 Provide a factory installed ground termination block sized for the grounding conductor indicated on the Drawings.
- .3 Provide operator handle mechanisms that are padlockable in the "OFF" position. In the case of electrically operated breakers, provide a permanently installed device for padlocking in the "OFF" position.
- .4 All enclosed circuit breakers shall have nameplates that contain a permanent record of catalog number and maximum rating.
- .5 Enclosures shall be finished using the manufacturer's standard process and shall be ANSI 61 gray color.

3. Execution

3.1 INSTALLATION

- .1 Install circuit breaker enclosures plumb with suitable supports and per manufacturer's recommendations. Where mounted on concrete wall, install with 1/2 inch (13 mm) steel spacers behind the switch enclosure. Mounting attachments and connections shall be designed in conformance with the minimum lateral seismic force of 0.5W per CBC.
- .2 Height: Install top of circuit breaker enclosure 78 inches (1980 mm) above finished floor, unless otherwise noted on drawings.
- .3 Provide engraved nameplates with the designation indicated on the Drawings.
- .4 Perform field adjustments of the circuit breakers as required to place the equipment in final operating condition. The settings shall be in accordance with the approved protective device coordination study or as directed by the Project Manager.

3.2 FIELD QUALITY CONTROL

- .1 Comply with requirements of NETA Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems and the manufacturer's inspection, testing, calibration and start-up procedures. The manufacturer's technician shall perform inspection, testing, calibration and start-up, with assistance from the Subcontractor as necessary, and in the presence of the University's representative. Schedule testing and start-up with at least ten (10) working days advance written notification.
- .2 Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and check tightness of connections with a calibrated torque wrench.
- .3 Electrical Tests: Measure and record insulation resistance of the enclosed circuit breaker and its components (phase-to-phase and phase-to-ground) prior to energization. The Subcontractor shall not be responsible for defective insulation in equipment that has been supplied by the University, unless such damage is due to negligence or incorrect handling or installation workmanship of the Subcontractor.
 - .1 The insulation resistance of each circuit phase-to-phase and phase-to-ground shall be measured. For circuits rated less than 600 volts, the resistance shall not be less than 100 megohms.
 - .2 Systems rated above 240 volts shall be tested with a 1000-volt Megohmmeter. Circuits rated 240 volts and below shall be tested with a 500-volt Megohmmeter. The D.C. potential shall be applied for thirty (30) seconds.
 - .3 Test and record phase rotation (clockwise) and sequence (A-B-C).
- .4 Provide the University with five (5) certified copies of field test reports.

END OF SECTION

1. General

1.1 SECTION INCLUDES

- .1 Equipment, fabrication and installation for ground fault protection.
- .2 See Section 26 23 00 - Low Voltage Switchgear.
- .3 See Section 26 24 02 - Service Entrance Board.

1.2 RELATED SECTIONS

- .1 Section 01 29 83 - Payment Procedures for Testing Laboratory Services.
- .2 Section 01 33 00 - Submittal Procedures.
- .3 Section 01 45 00 - Quality Control.
- .4 Section 01 91 13 – General Commissioning (Cx) Requirements.
- .5 Section 26 05 00 – Common Work Results - Electrical.

1.3 PAYMENT PROCEDURES

- .1 Pay for field testing of ground fault equipment performed by equipment manufacturer.

1.4 REFERENCES

- .1 Canadian Standards Association (CSA)
- .2 CAN/CSA-C22.2 No. 144, Ground Fault Circuit Interrupters.
- .3 National Electrical Manufacturers Association (NEMA)
- .4 NEMA PG 2.2, Application Guide for Ground Fault Protection Devices for Equipment.

1.5 SUBMITTALS

- .1 Submit product data and shop drawings.
- .2 Submit test report for field testing of ground fault equipment to Departmental Representative and certificate that system as installed meets criteria specified.

2. Products

2.1 EQUIPMENT

- .1 Ground fault protective equipment: components of one manufacturer.
- .2 Provide ground fault protection on 1000A, 600V, 4 wire, 3 phase service and 2000 A, 208V, 4 wire, 3 phase service and above: to NEMA PG 2.2 and CAN/CSA-C22.2 No. 144.
- .3 Ground fault unit to contain:
 - .1 Ground sensing relay suitable for operation at 500 mA as indicated on electrical drawings. Control voltage: 120 V.
 - .2 Ammeter with scale 0 to 5 A to indicate ground current value.
 - .3 Three position sensitivity control switch to select value of leakage current at which relay will operate.
 - .4 Indicating lamp illuminated when no ground fault exists, extinguished on ground fault or test.
 - .5 Switch:
 - .1 SPDT contacts for alarm and trip.
 - .2 Mechanical target indication.
 - .3 Manually reset.
 - .6 Reset button for contacts and target.
 - .7 Suitable for panel mounting.

- .4 Zero sequence transformer toroidal type with 300 - 3000 mA range.
- .5 Neutral:
 - .1 Use an artificial neutral and grounding resistor.
 - .2 Use neutral ground resistor unit.
- .6 System to operate instantaneously at ground current setting.

2.2 FABRICATION

- .1 Install following components in equipment specified in other Sections and as indicated.
 - .1 Zero sequence transformer.
 - .2 Ground fault relay.
 - .3 Ground resistor unit.

2.3 RELATED EQUIPMENT

- .1 Shunt trip breakers. Load break disconnect switch.

3. Execution

3.1 INSTALLATION

- .1 Do not ground neutral on load side of sensor.
- .2 Install phase conductors including neutral through zero sequence transformer.
- .3 Install ground fault protection system.
- .4 Make connections as indicated and in accordance with manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 – Common Work Results - Electrical and Section 01 91 13 – General Commissioning (Cx) Requirements.
- .2 Arrange and pay for field testing of ground fault equipment by ground fault equipment manufacturer before commissioning service.
- .3 Check trip unit settings to ensure proper working operation and protection of components.
- .4 Demonstrate simulated ground fault tests.

END OF SECTION

1. General

1.1 RELATED IN SPECIFIED IN OTHER SECTIONS

- | | | |
|----|-------------------------------|------------------|
| .1 | General Requirements | Division 1 |
| .2 | General Electrical Provisions | Section 26 05 01 |
| .3 | Main Distribution Equipment | Section 26 24 13 |
| .4 | Panelboards | Section 26 24 17 |

1.2 REGULATORY REQUIREMENTS

- .1 Units to list CSA approval.
- .2 Size with voltage, current and interrupting capacities required by the Canadian Electrical Code.

2. Products

2.1 MOULDED CASE BREAKERS

- .1 Moulded case automatic circuit breakers: 600 and 250 volt bolt-in type with thermal and magnetic trip, quick make/ quick break type, trip free position separate from "On" or "Off" positions, for manual and automatic operation, interrupting rating minimum 10 kA or as indicated in panel schedules or as required for application. Common trip breakers shall have single handle for multi-pole applications. Wafer or duplex type breakers will not be accepted. Width of breaker to be minimum 25 mm per pole.
- .2 Ground fault Interrupting Breakers: As above with 5 mA or 30 mA leakage trip to suite application. All heat trace circuits to be installed with 30 mA trip. Install ground fault protection as indicated on drawings and at breakers required by the CEC

2.2 ENCLOSURES

- .1 Where separately mounted outside equipment, to be CSA Type 1 or 2 in dry, heated areas, EEMAC Type 3 in outdoor locations, and EEMAC Type 4 in corrosive atmosphere.

3. Execution

3.1 INSTALLATION

- .1 Install disconnect switches as required by the CEC and as indicated on the drawings. All motors shall have a disconnect installed at the motor. Remote disconnect such as breakers are not acceptable.
- .2 Factory install breakers in panel boards in size and quantity indicate on the panel boards schedules.
- .3 Install correct type and size of fuse in fused disconnects.

END OF SECTION

1. General

1.1 DESCRIPTION

- .1 Provide disconnect switches for 120/208 volt distribution as indicated on the drawings, as manufactured by Schneider, Cutler Hammer, Siemens & Eaton.
- .2 Disconnects to be to CAN/CSA C22.2 No. 4-M89 and required by CEC to suit application.

2. Products

2.1 DISCONNECT SWITCHES

- .1 Ratings: 600/240 volts for 120/208-volt distribution. Unless otherwise shown, 3 pole for 3 phase, 3 wire distribution, 3 pole and solid neutral for 3 phase 4 wire distribution. Ampere ratings as shown on the drawings or to suit load requirements. For motors, use disconnect switches with HP ratings at least equal to motor HP.
- .2 Enclosures: CSA code gauge galvanized steel, hinged doors, external operating handles. Disconnect switches in dry locations shall be EEMAC-2 and EEMAC-3 where exposed to weather.
- .3 Finish: One primer coat and one finish coat on all metal surfaces, colours as per Section 26 05 01.
- .4 Switch mechanisms: Quick make and quick break action with self wiping contacts, solderless pressure lug connectors. For switches 100 amperes and over, provide non-tracking arc shrouds. All switch poles to operate together from a common operating bar. Provide for padlocking disconnect switches in "Off" position. Doors to be interlocked and complete with defeat mechanism.
- .5 Neutral Bars: Where distribution system has grounded neutral conductor, provide neutral bar where required with ampere rating equal to switch rating, in enclosure. Provide ground bar for terminating ground conductors.
- .6 Fuse Holders: Provide fuse holders on load side of switches, ampere rating equal to switch ratings, suitable for fuses specified.

2.2 FUSES

- .1 All fuses to be 100,000 ampere (minimum) interrupting capacity of the current limited type. In addition, fuses feeding motors to be of the time delay type. Provide one full set of spare fuses, three for each different ampere rating used, stored in suitable enclosure.

3. Execution

3.1 DISCONNECT SWITCHES

- .1 Mounting: Provide supports independent of conduits. Wall mount where possible, otherwise, provide Unistrut frame support. Where switches are grouped mount in uniform arrangement.
- .2 Wiring: Connect line and load cable to all switches.
- .3 Fuse Rating: Install so that the rating is visible.

- .4 Identification: Provide lamacoid plate on each switch showing voltage, source of supply and load being fed, for example:

Door Controller
120/208 Volts
Fed from PPA
- .5 Install disconnect switches complete with fuses as indicated on drawings.

END OF SECTION

1. General

1.1 RELATEDWORK

- .1 Mechanical

1.2 WORKINCLUDED

- .1 Installation of Variable Speed Drives to be completed by this Division as per mechanical specifications.
- .2 The system shall be complete and shall include all components necessary to comprise as a functional system.

1.3 RELATEDWORK BY OTHERS

- .1 Mechanical Contractor to supply Variable Speed Drives as per mechanical specifications.

2. Products

- .1 Not used

3. Execution

3.1 GENERAL

- .1 The Mechanical Contractor shall provide the VFD manufacturer a shop drawing of each motor application, to ensure that VFD(s) and motors are fully compatible.
- .2 Motor application data are shown on the mechanical drawings / specifications.

3.2 INSTALLATION

- .1 Electrical Contractor to install VFD(s), filters, and associated equipment in locations as indicated on drawings, and cooperate with Division 23 regarding connecting up all necessary wiring.

END OF SECTION

1. General

1.1 RELATEDWORK

- | | | |
|----|---|------------------|
| .1 | General Electrical Requirements | Section 26 05 01 |
| .2 | Luminaire Schedule (Unless on drawings) | Section 26 51 00 |
| .3 | Exit Lights | Section 26 53 00 |

1.2 WORKINCLUDED

- .1 This section includes for the supply and installation of luminaires complete with lamps, driver, supports and accessories, and for the supply of plaster frames, trim rings and back boxes for plaster or dry wall ceilings or concrete.

1.3 CODE REQUIREMENTS

- .1 Installation of lighting equipment to conform to the current edition of the Canadian Electrical Code as amended and supplemented by provincial, municipal or other regulatory agencies having jurisdiction.
- .2 Luminaires to conform to CSA C22.2 No. 9, ANSI C82.1 and lamps to ANSI C78. LED drivers with ENEC mark and EMC tested, IP20 for indoor and IP65 for outdoor

1.4 COORDINATIONWITH OTHER DIVISIONS

- .1 Confirm compatibility and interface of other materials with luminaire and ceiling system. Report discrepancies to the A/E and defer ordering until clarified.
- .2 Supply plaster frames, trim rings and back boxes to other trades as the work requires.
- .3 Coordinate with other trades to avoid conflicts between luminaires, supports and fittings and mechanical or structural building elements.

1.5 SHOPDRAWINGS

- .1 Submit a complete list of the types of lighting luminaires, lamps, ballasts and accessories with catalogue illustrations, data sheets, etc., for review.
- .2 Submit complete photometric data based on actual luminaires proposed for the project. Photometric data must be produced by an independent testing laboratory.

1.6 SAMPLES

- .1 Provide samples of luminaires, lamps, drivers and accessories when requested by the A/E.

2. Products

2.1 GENERAL

- .1 Provide, wherever possible, commercially available luminaires meeting the specified requirements and as indicated on the drawings. Different luminaires may be supplied by different manufacturers. Similar luminaires shall be supplied by the same manufacturer.
- .2 It is Contractors responsibility to perform all NECB calculation and get approvals from City if different fixture is utilized. Submit alternate specification to PCA Departmental Representative prior to tender close. Alternate specifications are only valid with PCA Departmental Representative written approval.
Alternates specifications are not allowed for exterior luminaires. Provide as per Specifications on the drawings.

Recessed pot-lights shall be of the pre-wired type with the junction box and, where applicable, the ballast forming an integral part of the assembly with satisfactory access. Unit shall be complete with plaster rings and supports as required. Ballasts
- .3 Provide only luminaires which are structurally well designed and constructed and which use new materials of the highest commercial grade available. Unless specifically noted otherwise, luminaires to be of the quality stated in the manufacturers catalogues and data sheets. Luminaires shall be designed for adequate dissipation of ballast and lamp heat.
- .4 Louvres shall be supplied by this division and shall be acrylic with finish as specified or as selected by PCA Departmental Representative.
- .5 Use self-aligning ball joint hangers for stem suspended luminaires.
- .6 Use cadmium plated chains for suspended luminaires in unfinished areas.
- .7 Supply and install aligning channels for mounting suspended continuous row luminaires.

2.2 LED LUMINAIRES

- .1 Light Emitting Diodes (LED)
 - .1 CRI shall be greater than or equal to 75.
 - .2 Rated LED life time shall demonstrate 70% lumen maintenance at 35,000 hours as defined in the IESNA standards.
 - .3 LED's shall be IES LM-79 and LM-80 tested and certified.
- .2 LED Drivers (Electronic- Instant Start)
 - .1 Drivers shall comply with ANSI C62.41 Category A for Transient protection.
 - .2 Driver to be compliant with ROHS.
 - .3 Driver to be EMI compliant in accordance with FCC 47 Sub Part 15, CISPR 15, CISPR 22 Class A, EN61000-3-2, -3-3, -4-4, -4-5.
 - .4 Driver to be compliant with Safety regulations in accordance with UL879, UL1012, UL935, IEC61347-2-2, EN61558-1, EN61558-2-17, EN60065, IEC6100-4-5.
 - .5 Drivers shall contain no PCB's nor mercury.
 - .6 Drivers shall be primary fused.
 - .7 Output ripple maximum 10%
 - .8 Temperature: -40 to +80 degree Celsius for exterior luminaires, 0 to +80 degree Celsius for interior luminaires,
 - .9 Efficiency minimum 93%.
 - .10 Power factor >0.9 at full load.
 - .11 Input 120V
 - .12 Output 120 – 425 VDC, 0.35Amp ±5%.
 - .13 Frequency 50-60 Herz.
 - .14 Total Harmonic Distortion < 10% at Full Load at 120 Volt and <15% at 347 Volt.
 - .15 Driver to be fully encased and potted.
 - .16 Life time rated at minimum 50,000 hours.

3. Execution

3.1 INSTALLATION

- .1 Install recessed luminaires to permit removal from below to gain access to outlet or pre-wired luminaire box. Make final connection from boxes to luminaires with flexible conduit. AC-90 (with No. 14 AWG conductors) may be used but shall be independently supported, (e.g., not from the connectors), and have anti-shorts installed. With either type of connection method, the length of the flexible connection shall not exceed 2 meters.
- .2 For recessed luminaires in particular for HID pot-lights and fluorescent luminaires, support luminaire independent of suspended ceiling system.
- .3 Where luminaires are surface-mounted on T-bar ceilings, support unit from structure and stabilize luminaire with sheet metal screws into a T-bar at both ends.
- .4 When luminaires are installed in valances with solid lens, ensure presence of adequate ventilation openings into ceiling space to dissipate heat.

3.2 WORKMANSHIP

- .1 Completely clean all luminaires, including lenses, lamps, hangers and interiors at completion of project and before final acceptance of project.
- .2 Provide suitable extension couplings for wall mounted luminaires.
- .3 Hang and mount luminaires to prevent distorting frame, housing, sides or lens frame and permit correct alignment of several luminaires in a row.
- .4 Support luminaires as indicated on the drawings, level and plumb and true with structure and other equipment in horizontal or vertical position as intended. Install wall or side bracket mounted luminaire housings rigidly and adjust to a neat flush fit with mounting surface.
- .5 Install ceiling canopies to cover suspension attachments and fit tightly to ceiling without restricting alignment of hanger.
- .6 Where luminaires are required to be supported from the building structure, use a minimum of 2 - 6.35 mm rods per luminaire.
- .7 For remotely mounted ballasts, supply mounting boards and space ballasts in accordance with manufacturer's direction. Size wiring from ballast to remote luminaires to meet manufacturer's requirements.
- .8 Remove any noisy ballasts from the luminaires and replace at no additional cost to the Owner prior to completion and final acceptance of the installation.
- .9 Coordinate entire installation with other trades prior to rough stage on site to avoid conflicts. During installation, locate ductwork and any other items that may cause interference in the ceiling space. Notify general contractor M and E coordinator promptly of any conflicts.
- .10 In mechanical rooms and areas install lighting after piping and ductwork is installed to permit final light locations to be determined. Allow for additional necessary chain, hanger
- .11 rods and supports as may be necessary.

3.3 BRANCH CIRCUIT WIRING

- .1 Where the drawings do not show conduit routing or conduit sizes and wire counts, supply and install a complete system of conduit and wire for the lighting system. Make all connections and install all conductors for the switching and branch circuiting indicated and required. Run conduit parallel to major building lines.
- .2 Conductors shall be #12 R90 x-link minimum.
- .3 Conduits shall be sized in accordance with code requirements for the wire count installed. In no case shall conduit less than 21 mm be used for home runs. Base conduit fill on maximum of six phase conductors per conduit, resulting in a derating of 80% as per CEC 4-004 (1) (C).
- .4 Special lamps not specified in this Section to be as called for in the Luminaire Schedule.
- .5 All lamps supplied to be suitable for luminaire burning position.

3.4 LUMINAIRE ALIGNMENT AND CLEANING

- .1 Align luminaires in continuous rows to form straight uninterrupted line.
- .2 Align individual mounted luminaires parallel or perpendicular to building lines.
- .3 Thoroughly clean all fixtures, including reflectors , lamps diffusers louvers and lenses.
- .4 Adjust lenses, frames and trims to eliminate light leaks.

3.5 LUMINAIRE SUPPORTS

- .1 For suspended ceiling installations support luminaires from ceiling grid in accordance with local inspection requirements.
- .2 Install blocking behind drywall mounted fixtures to support luminaire. Do not mount fixture to drywall with inserts or toggle bolts.
- .3 Fixtures surface mounted on t-bar shall be support with approved t-bar clips.
- .4 Support fixtures in T-Bar tiles with 13 by 38 mm channel supports that are tied to the ceiling support system.
- .5 Combustible materials such as wood blocking may not be used in ceiling spaces to support fixtures or electrical items.

END OF SECTION

1. General

1.1 WORK INCLUDED

- .1 Supply emergency lighting units complete with all accessories.

1.2 SPECIAL CODES

- .1 Canadian Electric Code, Part 1, Section 46 "Emergency Systems, Unit Equipment and Exit Signs".
- .2 CSA Standard C22.2 No. 141-M1985 "Unit Equipment for Emergency Lighting".
- .3 National Building Code and BC Building Code.

2. Products

2.1 GENERAL

- .1 Supply and install battery power emergency lighting where shown on the drawings. Lights are to switch "ON" automatically in the event of failure of normal power, and "OFF" on restoration of power. The batteries shall be automatically recharged from a 120 VAC supply, Output Voltage 24 V.

2.2 LINE CONNECTION

- .1 Each battery unit shall be equipped with AC line cord and plug.

2.3 UNITS

- .1 Units to contain solid state battery charger, transfer switch and batteries. Provide all relays, hardware and circuitry for operation specified. Units to have push-to-test switch, "ON" and "charging" lights with extended lamp life and be complete with automatic self diagnostic circuitry.

2.4 BATTERIES

- .1 Unless specifically indicated, of sufficient watt-hour capacity to power the loads connected to each individual unit for 30 minutes, 12 volt, 10 year long life sealed lead acid batteries, contained within the units.
- .2 DC Power: Flexible conduit to be an electrical box.

2.5 HEADS

- .1 Remote and/or integral lighting heads to be as shown on drawings. Fixtures to be adjustable 4W/24V LED MR16 type.
- .2 Wire guards to be installed on all remote heads in the locker rooms and gymnasiums.

2.6 MOUNTING BRACKET

- .1 Metal Shelf type, specifically made for unit supplied.

2.7 MANUFACTURER

- .1 Stanpro see drawings for model no. & wattage information complete with mounting bracket and automatic self Diagnostic circuitry. Other approved manufacturers: Emergi-Lite, Ready-Lite, Dual-Lite, Aim Lite.

2.8 LOW VOLTAGE DISCONNECT

- .1 To disconnect battery on drop in voltage at a level which will damage the battery permanently, i.e. below 85% of nominal voltage.

3. Execution

3.1 INSTALLATION

- .1 Mount battery units with the bottom of the enclosure not less than 2.2 m above the floor, where practicable.
- .2 Install duplex receptacle adjacent to unit and connect to 1Ø 120V unswitched area lighting circuit.
- .3 Where applicable wire from unit to DC circuitry in exit lights.
- .4 Wiring from units to remote heads and/or exit lights shall be sized to prevent voltage drop of more than 5%.

END OF SECTION

1. General

1.1 RELATEDWORK

- | | | |
|----|---|------------------|
| .1 | General Electrical Requirements | Section 26 05 01 |
| .2 | Lighting Equipment | Section 26 50 00 |
| .3 | Luminaire Schedule (unless on drawings) | Section 26 51 00 |
| .4 | Unit Equipment for Emergency Lighting | Section 26 52 00 |
| .5 | Canadian Standards Association (CSA)
CSA C22.2 No.141, Unit Equipment for
Emergency Lighting.
CSA C860, Performance of Internally-Lighted Exit
Signs.

NFPA 101, Life Safety Code | |

1.2 WORK INCLUDED

- | | |
|----|--|
| .1 | Supply exit lights suitable for mounting as indicated, with lamps and accessories. |
| .2 | Provide heavy duty substantial wire guards on all exit lights in gymnasium. |

1.3 CODE REQUIREMENTS

- | | |
|----|---|
| .1 | Canadian Electrical Code, Part 1, Section 46, Emergency Systems, Unit Equipment and Exit Signs. |
|----|---|

2. Products

2.1 LUMINAIRES

- | | |
|----|--|
| .1 | Manufacture: Stanpro as shown on drawings or approved equals. Other approved manufacturers: Ready-Lite, Emergi-Lite., Lithonia, Aim lite |
| .2 | General Construction: Extruded aluminum faceplates, white finish, with letters cut through to expose fiberglass diffusers, with directional arrows as indicated on drawings. The LED sign shall consume less than five watts per face and shall have solid state design. |
| .3 | Mounting: End to wall, wall or ceiling, single or double sides as indicated. Multiple knock-outs for universal mounting not acceptable. |
| .4 | Units to be complete with integral battery and electronic components to allow for AC to DC automatic transfer. Battery to be rated for 10-year life and unit to be complete with self and manual test. |
| .5 | Provide heavy duty substantial wireguards on exit lights located in gymnasium. |

2.2 STANDARD UNITS

- | | |
|----|---|
| .1 | Exit lights: to CSA C22.2 No.141 and CSA C860, packaged in accordance with the Canadian Electrical Code for Preferred Packaging guidelines. |
|----|---|

- .2 Housing: cold rolled steel minimum 1.0 mm thick, satin aluminum enamel finish
- .3 Face and back plates: extruded aluminum.
- .4 Lamps: multiple - LED-4 W, 120 V, over 500,000 hours with average surface brightness of 3000 candela.
- .5 Operation: designed for 25 years of continuous operation without relamping.
- .6 Letters: 150 mm high x 19 mm, with 13 mm thick stroke red on extruded aluminum face, reading EXIT.
- .7 Downlight: white glass in bottom of unit.
- .8 Third lamp socket for emergency lamp lighting circuit.
- .9 Face plate to remain captive for relamping.

2.3 SELF-POWERED UNITS

- .1 Exit lights: to CSA C22.2 No.141 and CSA C860, packaged in accordance with the Canadian Code for Preferred Packaging guidelines.
- .2 Housing: cold rolled steel minimum 1.0 mm thick, satin aluminum enamel finish.
- .3 Face and back plates: extruded aluminum.
- .4 Lamps: multiple -, LED-12W 120 V over 500,000 hours.
- .5 Operation: designed for 25 years of continuous operation without relamping.
- .6 Letters: 150 mm high x 19 mm wide, with 13 mm thick stroke, red on extruded aluminum face, reading EXIT.
- .7 Downlight: white glass in bottom of unit.
- .8 Third lamp socket for emergency lamp lighting circuit.
- .9 Face plate to remain captive for relamping.
- .10 Supply voltage: 120 V, ac.
- .11 Output voltage: 12 or 24 V dc.
- .12 Operating time: minimum 30 minutes and as required by code.
- .13 Recharge time: 12 hours
- .14 Battery: sealed, maintenance free, warranty to Section 26 52 00 – Emergency Lighting, 1.5 – Emergency Lights.
- .15 Charger: solid state, voltage/current regulated, inverse temperature compensated, short circuit protected, with regulated output of plus or minus 0.01 V for plus or minus 10% V input variation.
- .16 Solid state transfer circuit.
- .17 Signal lights: solid state, for 'AC Power ON'.
- .18 Lamp heads: integral on unit, 345° horizontal and 180° vertical adjustment. Lamp type: as indicated.
- .19 Mounting: suitable for universal mounting directly on junction box and c/w knockouts for conduit. Removable or hinged front panel for easy access to batteries.
- .20 Cabinet: finish: standard.
- .21 Auxiliary equipment:
 - .1 Lamp disconnect switch.
 - .2 Test switch.
 - .3 AC/DC output terminal blocks inside cabinet.
 - .4 RFI suppressor.
 - .5 Cord and single twist-lock plug connection for AC power supply.

2.4 DESIGN X1

- .1 Recessed, wall, end to wall, ceiling mounting as indicated.
- .2 Single or double face with running man pictogram face plate to remain captive for relamping as indicated.

- .3 Arrow: right or left as indicated.
- .4 Wireguard

3. Execution

3.1 INSTALLATION

- .1 Install exit lights to manufacturer's recommendations, listing requirements, NFPA standard and local regulatory requirements.
- .2 Connect fixtures to exit light circuits using RW90 wire in EMT conduit.
- .3 Connect emergency lamp sockets to emergency circuits.
- .4 Ensure that exit light circuit breaker is locked in on position.
- .5 Provide tests in accordance with Section 26 05 00 – Common Work Results - Electrical and Section 01 91 13 – General Commissioning (Cx) Requirements.
- .6 Connect exit lights to separate branch circuits and to emergency battery packs as indicated. Provide red bolt on breaker for exit sign and Identify circuit breakers feeding exit light circuits and install locking straps.

3.2 CLEANING

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.
- .3 PVC conduit shall not be used with wiring for exit lights unless embedded in concrete or block wall.
- .4 Install exit lights on ceiling's only when not possible to wall mount. Install 6inch below ceiling level.

END OF SECTION

1. General

1.1 RELATED SECTIONS

.1	Identification	Section 26 05 53
.2	Conduits	Section 26 05 33
.3	Cable Trays	Section 26 05 36
.4	Outlet Boxes, Pull Boxes, Cabinets and Miscellaneous Raceways	Section 26 05 32
.5	Wiring Devices	Section 26 27 26
.6	Hangers, Supports and Inserts	Section 26 05 29
.7	Low Voltage Communication Raceway System	Section 27 05 28

1.2 SYSTEM DESCRIPTION

- .1 Structured telecommunications wiring system consist of unshielded-twisted-pair and optical fiber cables, terminations, connectors, cross-connection hardware and related equipment installed inside building for occupant's telecommunications systems, including voice (telephone), data. Conduit, cabling and outlets to form a complete and operating Category 6 horizontal cabling system for data and telephone as indicated on the drawings and detailed in this specification.
- .2 Provide all cabling and associated components as described in the specifications and drawings.
- .3 Cable system shall have end-to-end Category 6 rated products with components manufactured by a single manufacturer.
- .4 Approved manufacturers are: AMP, Belden, Systimax, Leviton and Panduit.
- .5 Install voice and data backbone cables in conduit as indicated on the drawings. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure.
- .6 Backbone cabling systems consists of backbone cables, intermediate & main cross-connects and mechanical terminations.
- .7 The communication cabling system shall be supplied and installed as a sub-contract to Division 26 – Electrical.

1.3 REFERENCES

- .1 The following industry standards are the basis for the structured cabling system described in this document
- .2 Canadian Standards Association (CSA International)
 - .1 C22.2 NO. 214-08 – Communications cables (Bi-national standard, with UL 444)

- .2 C22.2 NO. 232-09 – Optical fiber cables
- .3 CAN/CSA C22.1-06 – Canadian Electrical Code.
- .3 Telecommunications Industry Association (TIA)/Electronic Industries Alliance (EIA)
 - .1 ANSI/TIA-568-C.1–2009+A1:2012, Commercial Building Telecommunications Cabling Standard
 - .2 ANSI/TIA-568-C.2–2009+A1:2010, Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
 - .3 ANSI/TIA-568–C.3–2009+A1:2011, Optical Fiber Cabling Components Standard
 - .4 ANSI/TIA-568–C.4–2011, Broadband Coaxial Cabling and Components Standard
 - .5 ANSI/TIA-569-C–2012, Telecommunications Pathways and Spaces
 - .6 ANSI/TIA/EIA–598–C–2005, Optical Fiber Cable Color Coding
 - .7 ANSI/TIA–606–B–2012, Administration Standard for Commercial Telecommunications
 - .8 ANSI/TIA–607–B–2011, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 - .9 ANSI/TIA–758–B–2012, Customer-Owned Outside Plant Telecommunications Infrastructure Standard
 - .10 ANSI/TIA–862–A–2011, Building Automation Systems Cabling Standard
 - .11 ANSI/TIA–942–A–2012, Telecommunications Infrastructure Standard for Data Centers.
 - .12 ANSI/TIA–1152–2009, Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
 - .13 NFPA
 - .1 NFPA 70 National Electric Code (NEC)
 - .14 ISO/IEC
 - .1 ISO 11801 Generic Cabling for Customer Premises
- .4 If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.
- .5 This document does not replace any code, either partially or wholly. The contractor must be aware of local codes that may impact this project.

1.4 SUBMITTALS

- .1 Prior to start of work the contractor shall submit copies of the certification of the company and names of staff that will be performing the installation and termination of the installation to provide proof compliance of this specification. The contractor shall employ a Registered Communication Distribution Designer who has current RCDD membership with BICSI.
- .2 Submit appropriate cut sheets and samples of all products, hardware and cabling.
- .3 Do not start any part of the telecommunications system installation until approval for all system shop drawings have been approved. Installer is to confirm pathways from outlet to rack will accommodate maximum cable length including service lops prior to materials arriving on site

- .4 The Contractor shall receive approval from the Owners on all substitutions of material. No substituted materials shall be installed except by written approval from the Owner.

1.5 QUALITY ASSURANCE

- .1 The Contractor shall provide a complete warranty to guarantee a high performance cabling systems that meet application requirements. The guarantee shall include all cable installed in the structured cabling system. The Cable shall be warranted for a period of at least 25 years.
- .2 The installing contractor shall submit proof that they are certified by the manufacturer of the system components to install and certify the system.

1.6 DRAWINGS

- .1 It shall be understood that the electrical details and drawings provided with the specification package are diagrammatic. They are included to show the intent of the specifications and to aid the contractor in bidding the job. The Contractor shall make allowance in the bid proposal to cover whatever work is required to comply with the intent of the plans and specifications. .
- .2 The telecommunications contractor shall verify all dimensions at the site and be responsible for their accuracy.
- .3 Prior to submitting the bid, the telecommunications contractor shall call the attention of the PCA Departmental Representative to any materials or apparatus the Contractor believes to be inadequate and to any necessary items of work omitted.

2. Products

2.1 HORIZONTAL DATACABLES

- .1 4 pair, Category 6 (CAT6) 23 AWG
- .2 Jacket colour – Blue FT 6 rated
- .3 The cable shall meet or exceed the requirements of ANSI/EIA/TIA 568-B-2.1.
- .4 The UTP-based cabling system shall use matched components from a single manufacturer, and the cabling system shall be certified to deliver system performance over the lifetime of the applications for which the cabling system was originally designed to support.

2.2 HORIZONTAL VOICE CABLE

- .1 4 pair, Category 6 (CAT6) 23 AWG UTP cable
- .2 Jacket colour – White FT6 rated
- .3 The cable shall meet or exceed the requirements of ANSI/EIT/TIA 568-B-2.1

- .4 The UTP-based cabling system shall use matched components from a single manufacturer, and the cabling system shall be certified to deliver system performance over the lifetime of the applications for which the cabling system was originally designed to support.

2.3 FIBER OPTIC BACKBONE CABLE

- .1 Fiber optic backbone cable to be a laser optimized 50/125 micron OM3 multi mode fiber surrounded by aramid strength members and a PVC outer jacket. Cable shall be tested to comply with ANSI/TIA-568-C.3. 12 strand Multi Mode Minimum from data room to each sub rack.
 - .1 Cable to have an FT6 compliant riser rated sheath.
 - .2 Terminate Fiber optic cable on rack mounted termination panels. Panels to come with integrated front trough with provisions for labeling and rear cable management bar.
 - .3 Fiber terminations to be Type SC . The optical fiber field-installable connector shall be field installable, without requiring epoxy or polishing.
 - .4 Terminate all fibers.
 - .5 Outdoor rated cable to be used for all inter-building pathways.
 - .6 Contractor shall supply and install a 12 strand MM fiber tie between each wiring closet/cabinet and main computer room location in the main communications room.
 - .7 Minimum bend radius Ten times the cable diameter or as per manufacturer's recommendation which ever is more stringent.

2.4 COPPER BACKBONE VOICE CABLE

- .1 Voice backbone to be a 25, 50 or 100 pair Cat 6 24 AWG, UTP, NEC/NFPA CMR rated and be independently verified for compliance. Cable shall meet or exceeds all TIA/EIA-568-A Category 5 and ISO 11801 Class D requirements.
- .2 Cable jacketing to be GRAY and shall be lead free. Cable shall be verified and characterized to 100 MHz Cable shall be supplied on reels.
- .3 Terminate cables on wall mounted IDC cross-connect systems. The wall mount frames shall be field terminated kits including all blocks, connecting blocks, and designationstrips.
- .4 Contractor shall supply and install a 50 pair CAT6 copper tie between demarcation locations to the main telephone room. Contractor shall supply and install a minimum of 25 pair Cat 6 copper tie between main telephone room and each wiring closets. Contractor may be required to increase cabling by 50 pair increments to ensure that a minimum 25% spare capacity exist when they confirm number of pair required to meet telephone requirements from each wiring closet.

2.5 CONNECTORS

- .1 Horizontal Data:
 - .1 Category 6 jacks.
 - .2 Telecommunication jacks shall be 8-position/8-conductor modular outlet accepting standard modular RJ45 type plugs and IDC terminations. Jacks shall have UL and CSA approval.
 - .3 Each modular jack shall be provided with a bend-limiting strain relief. The strain relief shall provide cylindrical support to limit the bend radius at the point of termination.

- .4 All terminations for this project shall use the T568A wiring scheme.
- .5 Colour – Blue
- .6 Horizontal Voice
- .1 Category 6 jacks.
- .2 Telecommunication jacks shall be 8-position/8-conductor modular outlet accepting standard modular RJ45 type plugs and IDC terminations. Jacks shall have UL and CSA approval.
- .3 Each modular jack shall be provided with a bend-limiting strain relief. The strain relief shall provide cylindrical support to limit the bend radius at the point of termination.
- .4 All terminations for this project shall use the T568A wiring scheme.
- .5 Colour – White

2.6 PATCH CORDS

- .1 Patch cords for interconnection of switches to patch panels supplied by Owner.

2.7 PATCH PANELS

- .1 Panels shall be available in 24 Port and 48 Port Configurations, with height of 1 RU (1.75 inches) for each group of 24.
- .2 Patch panel to come with removable rear mounted cable management bar front and rear identification labels.
- .3 Fiber patch panels to be 12 port panels with ST connectors at each termination point.

2.8 EQUIPMENT RACKS

- .1 Floor Mounted racks
 - .1 Racks to be 19" wide x 36" deep x 84" high, four posts, free standing equipment racks.. fabricated of 2.5 mm min painted steel., drilled and tapped both sides for No. 12 screws. Complete with grounding lug.
 - .2 Designed to accommodate standard width EIA 483 mm panels.
 - .3 Receptacle bar with 3m power cord , minimum 10 outlets complete with surge suppressor
 - .4 Refer to drawings for quantity and location.
 - .5 Equipment racks to be equal to Mid Atlantic R4 Series or equivalent.
- .2 Vertical Cable Management
 - .1 Panels shall protect network equipment by controlling cable bend radius and providing cable strain relief.
 - .2 The covers shall be able to hinge from either side yet still be easily removed to allow for quick moves, adds, and changes.
 - .3 Provide and install two (2) vertical cable management for each free standing rack.
 - .4 Vertical cable manager to be equal to Mid Atlantic DRCC-44 or equivalent.
- .3 Horizontal Cable Management
 - .1 Panels shall be a universal design mounting to EIA 19" racks and constructed of steel bases.

- .2 The covers shall be able to hinge from either side yet still be easily removed to allow for quick moves, adds, and changes.
- .3 Provide and install one (1) horizontal cable management for each patch panel.
- .4 Grounding and Bonding
 - .1 The facility shall be equipped with a Telecommunications Bonding Backbone (TBB). This backbone shall be used to ground all telecommunications cable shields, equipment, racks, cabinets, raceways, and other associated hardware that has the potential to act as a current carrying conductor. The TBB shall be installed independent of the building's electrical and building ground and shall be designed in accordance with the recommendations contained in the ANSI/TIA/EIA-607 Telecommunications Bonding and Grounding Standard.
 - .2 All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, etc., entering or residing in the TR or ER shall be grounded to the respective TGB or TMGB using a minimum #6 AWG stranded copper bonding conductor and compression connectors.
 - .3 All wires used for telecommunications grounding purposes shall be identified with a green or with a wrap of green tape insulation. Non-insulated wires shall be identified at each termination point with a wrap of green tape. All cables and busbars shall be identified and labeled in accordance with the System Documentation Section of this specification.
- .5 Firestop
 - .1 All penetrations through fire-rated building structures (wall and floors) shall be sealed with an appropriate firestop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure). Any penetrating item i.e., riser slots and sleeves, cables, conduit, cable tray, and raceways, etc. shall be properly firestopped.
 - .2 Firestop systems shall be UL Classified to ASTM E814 (UL 1479) and shall be approved by a qualified Professional Engineer (P.ENG.), licensed (Actual or reciprocal) in the Province where the work is to be performed. A drawing showing the proposed firestop system, stamped/embossed by the P.ENG. shall be provided to the Owner's Technical Representative prior to installing the firestop system (s).

3. Execution

3.1 INSTALLATION

- .1 shall be installed in accordance with manufacturer's recommendations and best industry practices.
- .2 A plastic or nylon pull cord with a minimum test rating of 90 kg (200lb.) shall be co-installed with all cable installed in any conduit.
- .3 Cables at equipment racks shall be neatly bundled with Velcro tie wraps.
- .4 All telecommunication and data wiring to be installed in cable trays and conduit as detailed on the drawings. Cable raceways shall not be filled greater than the ANSI/TIA/EIA-569-A maximum fill for the particular raceway type of 40%.
- .5 The cable's minimum bend radius and maximum pulling tension shall not be exceeded.

- .6 Do not exceed the maximum tensile strength rating of the cable when pulling into conduit or cable trays. Pulling tension on 4-pair UTP cables shall not exceed 25-lbf for a four-pair UTP cable.
- .7 Provide horizontal and vertical wire management accessories on the equipment racks to route incoming horizontal cables in an orderly manner.
- .8 At each equipment rack, provide 3 meter cable loop to allow for future rack relocation within the equipment room. Neatly tie cable loop to the equipment rack.
- .9 Cable may not be spliced. Secure and support cables at intervals not exceeding 30" and not more than 6" from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
- .10 Separation from EMI Sources:
 - .1 Comply with BICSI TDMM and TIA / EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources including electrical power lines and equipment.
 - .2 Separation between open communication cables or cables in non-metallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - .1 Electrical Equipment Rating Less Than 2 kVA: a minimum of 5 inches (127mm).
 - .2 Electrical Equipment Rating Between 2 and kVA: a minimum of 12 inches (300mm)
 - .3 Electrical Equipment Rating More Than 5kVA: a minimum of 24 inches (610mm).
 - .3 Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - .1 Electrical Equipment Rating Less Than 2kVA: a minimum of 2.5 inches (64mm).
 - .2 Electrical Equipment Rating Between 2 and 5kVA: a minimum of 6 inches (150mm).
 - .3 Electrical Equipment Rating More Than 5kVA: a minimum of 12 inches (300mm).
 - .4 Separation between communication cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosure shall be as follows:
 - .1 Electrical Equipment Rating Less than 2kVA: No Requirement.
 - .2 Electrical Equipment Rating Between 2 and 5kVA: a minimum of 3 inches (76mm).
 - .3 Electrical Equipment Rating More Than 5kVA: a minimum of 6 inches (150mm).

3.2 CABLE TERMINATION

- .1 shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-B standard document, manufacturer's recommendation and best industry practice.

- .2 Pair untwist at the termination shall not exceed 12mm (one-half inch). Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.
- .3 The cable jacket shall be maintained to within 25mm (one inch) of the termination point.
- .4 Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.
- .5 Cable termination shall start at the upper left point of the terminal block mount and proceed in a left to right manner downward for each succeeding cable row.
- .6 All cross-connection data cables to the equipment rack shall be run down the backside of the cable raceway between the racks and up before terminating on the back side of the patch panels.

3.3 FIRESTOP SYSTEM

- .1 All firestop systems shall be installed in accordance with the manufacturer's recommendations and shall be completely installed and available for inspection by the local inspection authorities prior to cable system acceptance.
- .2 Comply with TIA/EIA-569-9, Annex A, "Fire Stopping".

3.4 GROUNDING SYSTEM

- .1 The TBB shall be designed and/or approved by a qualified P.ENG., licensed in the Province that the work is to be performed. The TBB shall adhere to the recommendations of the ANSI/TIA/EIA-607 standard, and shall be installed in accordance with best industry practice.
- .2 A licensed electrical contractor shall performed installation and termination of the main bonding conductor to the building service entrance ground.

3.5 LABELING

- .1 All labels shall be mechanically generated. All network labeling applications shall be performed as described in TIA/EIA-606-A Administration Standard for Commercial Telecommunications Infrastructure.
- .2 NOTE: The contractor shall confirm labeling criteria with the PCA Departmental Representative and Owner prior to labeling cables.

3.6 TESTING

- .1 General: All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA/EIA-568-B. All pairs of each cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed.
- .2 Consult with PCA Departmental Representative if cable test over length for replacement or

.3 Copper Channel Testing:

- .1 All twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance as indicated below. Additional testing is required to verify Category performance. Horizontal cabling shall be tested using a Level 3 test unit for Category 6 performance compliance.
- .2 Continuity: Each pair of each installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. The test shall be recorded as pass/fail as indicated by the test unit and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.
- .3 Length: Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the ANSI/TIA/EIA-568-B Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cables, the shortest pair length shall be recorded as the length for the cable.
- .4 Category 6 performance: For performance testing should be done according to the published ANSI/TIA/EIA-568-B.2-1

.4 Optical Fiber Cable Tests

- .1 Test instruments shall meet or exceed applicable requirements in TIA/ EIA-568C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- .2 Link End to End Attenuation Tests:
 - .1 Horizontal and multimode backbone link measurements. Test at 850 or 1300 nm in one direction according to TIA / EIA-526-14-A, Method B, One Reference Jumper.
 - .2 Attenuation Test results for backbone links shall be less than 2.0db. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568B.1.

.5 Record results on cabling contractor supplied forms as accepted by the Owners representative.

.6 The owner and/or Owners representative reserves the right to request additional testing when failures are encountered.

.7 Submit test results to the Owner for review and place in O&M Manual

.8 The Owner reserves the right to perform random tests prior to project closeout.

3.7 PRODUCTS PROVIDED BY THE OWNER

- .1 Owner will provide and install all active equipment components, including UPS.
- .2 Coordinate active equipment locations with the Owner prior to terminating cables.

3.8 SYSTEM DOCUMENTATION

- .1 Completion of the installation, the telecommunication contractor shall provide one (1) full documentation set and one (1) electronic set to the PCA Departmental Representative for approval.
Documentation shall include the items detailed in the sub-section below.
- .2 Documentation shall be submitted within then (10) working days of the completion of each testing phase (e.g. subsystem, cable type, area, floor, etc.). This is inclusive of all test results and draft as-built drawings. Draft drawings may include annotations done by hand. Machine generated (final) copies of all drawings shall be submitted within 30 working days of the completion of each testing phase.
- .3 The PCA Departmental Representative May request that a 10% random field re-test be conducted on the cable system, at no additional cost, to verify document findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the telecommunications contractor, additional testing can be requested to the extent determined necessary by the PCA Departmental Representative, including a 100% re-test. This re-test shall be at no additional cost to the Owner.
- .4 **Test Results:** Documentation shall be provided in electronic format within three weeks after the completion of the project. The media shall be clearly marked on the outside front cover with the words "Project Test Documentation", the project name and the date of completion (month and year). The results shall include a record of test frequencies, cable type, conductor pair and cable (or outlet) I.D., measurement direction, reference setup, and crew member name(s). The test equipment name, manufacturer, model number, serial number, software version and last calibration date will also be provided at the end of the document. Unless the manufacturer specifies a more frequent calibration cycle, an annual calibration cycle is anticipated on all test equipment used for this installation. The test document shall detail the test method used and the specific settings of the equipment during the test as well as the software version being used in the field test equipment.
- .5 The **As-Built** drawings are to include cable routes and outlet locations. Their sequential number as defined elsewhere in this document shall identify outlet locations. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided. The Owner will provide floor plans in paper and electronic (DWG, AutoCAD rel. 14) formats on which as-built construction information can be added. These documents will be modified accordingly by the telecommunications contractor to denote as-built information as defined above and returned to the Owner
- .6 The Contractors shall annotate the base drawings and return a hard copy (same plot size as originals) and electronic form (AutoCAD).

END OF SECTION

1. General

1.1 DESCRIPTION

- .1 Provide encased pvc conduit or fibre duct from property line to main telephone terminal board. Refer to drawings for location of telephone board, exact conduit size and Number of conduits required.
- .2 Contractor to coordinate entire telephone & cable vision installation with Utility company. Include cost in total tender price. Also coordinate with the owner to insure all costs are accounted for and the installation meets the Owner's needs.
- .3 Provide a #6 ground cable to main telephone board. Allow for minimum 200 pair cable installation from the Utility Company.
- .4 Telephone and cablevision outlet to be standard spec grade device box 50mm x 75mm c/w white cover plates. Terminate telephone wiring at appropriate outlets.
- .5 Supply and install "bix" blocks are required. Terminate all telephone cable on telephone board.

2. Products

2.1 CABLING

- .1 Voice cabling contractor to refer to Section 27 10 00 for all cabling requirements.

3. Products

3.1 DEVICES

- .1 Size all telephone outlet boxes and conduit as shown on drawings.
- .2 Provide pull boxes in all runs in excess of 30 meters or where more than two 90° bends occur.
- .3 Conduit shall conform to the requirements of Section and shall be a minimum 21mm.
- .4 Mount bottom of outlets at 1,500mm a box finished floor or as noted on drawings. Typically, in bottom of fourth block course in concrete block walls.
- .5 Junction boxes for outlets to be flush mounted in wall. Appropriate extension rings are to be provided where outlets are to be installed in millwork, backboards, chalkboards, etc.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 02 41 99 — Demolition for Minor Works.
- .2 Section 31 23 33.01 — Excavating Trenching and Backfilling.

1.2 REFERENCE STANDARDS

- .1 ASTM International
 - .1 ASTM C88-13, Test Method for Soundness of Aggregates by Use of Sodium Sulphate or Magnesium Sulphate.
 - .2 ASTM C136-14, Method for Sieve Analysis of Fine and Coarse Aggregate.
 - .3 ASTM C117-13, Test Method for Material Finer than 0.075 mm Sieve in Mineral Aggregates by Washing.
 - .4 ASTM D1557-12, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort.
- .2 CSA International
 - .1 CSA A23.1/A23.2-09, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

1.4 REGULATIONS

- .1 Shore and brace excavations, protect slopes and banks and perform all work in accordance with Provincial and Municipal regulations whichever is more stringent.
- .2 Not later than one week before backfilling or filling, provide to designated testing agency, 23 kg sample of backfill or fill materials proposed for use.
- .3 Do not begin backfilling or filling operations until material has been approved for use by the Departmental Representative.
- .4 Not later than 48 hours before backfilling or filling with approved material, notify the Departmental Representative so that compaction tests can be carried out by designated testing agency.
- .5 Before commencing work, conduct, with the Departmental Representative, condition survey of existing structures, trees and other plants, lawns, fencing, service poles, wires, rail tracks and paving, survey bench marks and monuments which may be affected by work.

1.5 TESTS AND INSPECTIONS

- .1 Testing of materials and compaction of backfill and fill will be carried out by a certified testing firm, retained by the Contractor and approved by the Departmental Representative.

1.6 BURIED SERVICES

- .1 Before commencing work, verify the location of all buried services on and adjacent to the site using ground penetrating radar.
- .2 Arrange with appropriate authority for relocation of buried services that interfere with execution of work. Pay costs of relocating services.
- .3 Remove obsolete buried services within 2 m of foundations. Cap cut offs.

1.7 PROTECTION

- .1 Protect excavations from freezing.
- .2 Keep excavations clean, free of standing water, and loose soil.
- .3 Where soil is subject to significant volume change due to change in moisture content, cover and protect to the Departmental Representative's approval.
- .4 Protect natural and manmade features required to remain undisturbed. Unless otherwise indicated or located in an area to be occupied by new construction, protect existing trees from damage.
- .5 Protect buried services that are required to remain undisturbed.

Part 2 Products

2.1 MATERIALS

- .1 Gravel to be composed of inert, durable material, reasonably uniform in quality and free from soft or disintegrated particles. In absence of satisfactory performance records over a five year period for particular source of material, soundness to be tested according to ASTM test procedure C-88 or latest revised issue. Maximum weight average losses for course and fine aggregates to be 30% when magnesium sulphate is used after five cycles.
- .2 All crushed gravel when tested according to ASTM C-136 and ASTM C-117, or latest revised issue, to have a generally uniform gradation and conform to following sieve must have one or more fractured faces. Determination of the Ministry of Transportation and Highways' Specification 1-11, Fracture Count for Coarse Aggregate, Method "A", which determines fractured faces by count. The Plasticity Index for crushed gravel to not exceed 6.0.
- .3 Native material to be any workable soil free of organic or foreign matter; any material obtained within limits of Contract may be deemed native material for purposes of

payment if it is approved by the Departmental Representative. Native material is not acceptable if it is impracticable to control its water content or compact to specified density.

.4 Granular Pipe Bedding and Surround Material

.1 Crushed or graded gravels: to conform to following gradation:

Percent Passing

Sieve	Type 1*	Type'2
25.0mm	100	100
19.0mm	90 - 100	90- 100
12.5mm	65 - 85	70- 100
09.5mm	50 - 75	
4.75mm	25 - 50	40- 70
2.36mm	10 - 35	25- 52
1.18mm	6 - 26	15- 38
0.600mm	3 - 17	6- 27
0.300mm	---	3- 20
0.075mm	0 - 5	0 - 8

*Type 1: standard gradation

*Type 2: to be used only in dry trench conditions and with Departmental Representative's prior approval.

.5 Top Soil for seeded areas: mixture of articulates, micro-organisms and organic matter which provides suitable medium for supporting intended plant growth.

.1 Soil texture: The Canadian System of Soil Classification, to consist of 20 to 70 % sand, minimum 7 % clay, and contain 2 to 10 % organic matter by weight.

.2 Contain no toxic elements or growth inhibiting materials.

.3 Finished surface free from:

.1 Debris and stones over 50 mm diameter.

.2 Course vegetative material, 10 mm diameter and 100 mm length, occupying more than 2% of soil volume.

.4 Consistencies: friable when moist

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions:
 - .1 Before commencing work verify locations of buried services on and adjacent to site.
- .2 Evaluation and Assessment:
 - .1 Arrange with appropriate authority for relocation of buried services that interfere with execution of work.
 - .2 Before commencing work, conduct, with Departmental Representative, condition survey of existing structures, trees and plants, lawns, fencing, service poles, wires, rail tracks and paving, survey bench marks and monuments which may be affected by work.

3.2 PREPARATION

- .1 Protection of in-place conditions:
 - .1 Keep excavations clean, free of standing water, and loose soil.
 - .2 Where soil is subject to significant volume change due to change in moisture content, cover and protect to Departmental Representative's approval.
 - .3 Protect natural and man-made features required to remain undisturbed. Unless otherwise indicated or located in an area to be occupied by new construction, protect existing trees from damage.
 - .4 Protect buried services that are to remain undisturbed.
- .2 Removal:
 - .1 Remove obsolete buried services within 2 m of foundations. Cap cut-offs.
 - .2 Remove obstructions, ice and snow, from surfaces to be excavated within limits indicated.
 - .3 Cut pavement or sidewalk neatly along limits of proposed excavation in order that surface may break evenly and cleanly.
 - .4 Remove trees, stumps, logs, brush, shrubs, bushes, vines, undergrowth, rotten wood, dead plant material, exposed boulders and debris within areas designated on drawings.
 - .5 Remove stumps and tree roots below footings, slabs, and paving, and to 200 mm below finished grade elsewhere.

3.3 EXCAVATION

- .1 Shore and brace excavations, protect slopes and banks and perform work in accordance with Provincial and Municipal regulations.
- .2 Topsoil stripping:

- .1 Do not handle topsoil while in wet or frozen condition or in any manner in which soil structure is adversely affected.
- .2 Strip topsoil to depths as directed by Departmental Representative. Avoid mixing topsoil with subsoil.
- .3 Strip topsoil over areas to be covered by new construction, over areas where grade changes are required, and so that excavated material may be stockpiled without covering topsoil.
- .4 Stockpile in locations as directed by Departmental Representative.
- .5 Dispose of topsoil to location as directed by Departmental Representative.
- .3 Excavate as required to carry out work, in all materials met.
 - .1 Do not disturb soil or rock below bearing surfaces. Notify Departmental Representative when excavations are complete.
 - .2 If bearings are unsatisfactory, additional excavation will be authorized in writing and paid for as additional work.
 - .3 Fill excavation taken below depths shown without Departmental Representative's written authorization with concrete of same strength as for footings at no extra cost to Departmental Representative.
- .4 Excavate trenches to provide uniform continuous bearing and support for 100 mm thickness of pipe bedding material on solid and undisturbed ground. Trench widths below point 300 mm above pipe not to exceed diameter of pipe plus 600 mm.
- .5 Excavate for slabs and paving to subgrade levels.
 - .1 Remove topsoil, organic matter, debris and other loose and harmful matter encountered at subgrade level.

3.4 SITE QUALITY CONTROL

- .1 Fill material and spaces to be filled to be inspected and approved by Departmental Representative.

3.5 BACKFILLING

- .1 Start backfilling only after inspection and receipt of written approval of fill material and spaces to be filled from Departmental Representative.
- .2 Remove snow, ice, construction debris, organic soil and standing water from spaces to be filled.
- .3 Lateral support: maintain even levels of backfill around structures as work progresses, to equalize earth pressures.
- .4 Compaction of subgrade: compact existing subgrade under walks, paving, and slabs on grade, to same compaction as specified for fill. Fill excavated areas with selected subgrade material compacted as specified for fill.
- .5 Placing:

- .1 Place backfill, fill and base course material in 150 mm lifts. Add water as required to achieve specified density.
- .2 Place unshrinkable fill in areas as indicated. Consolidate and level unshrinkable fill with internal vibrators.
- .6 Compaction: compact each layer of material to following densities for material to ASTM D1557:
 - .1 Boulevards and easements: minimum 90%.
 - .2 Roads, driveways, shoulders, re-shaped ditches and sidewalks: minimum 95%
 - .3 Basecourses: 100%.
 - .4 Elsewhere: 90%.
- .7 Under slabs and paving:
 - .1 In accordance with Contract Drawings.
- .8 In trenches:
 - .1 Up to 300 mm above pipe or conduit: sand placed by hand,
 - .2 Over 300 mm above pipe or conduit: native material approved by Departmental Representative.
- .9 Under seeded and sodded areas: use site excavated material to bottom of topsoil except in trenches and within 600 mm of foundations.
- .10 Blown rock material, not capable of fine grading, is not acceptable, imported material must be placed on this type of material.
- .11 Against foundations (except as applicable to trenches and under slabs and paving): excavated material or imported material with no stones larger than 200 mm diameter within 600 mm of structures.
- .12 Underground tanks: use sand to bottom of granular base courses or to bottom of topsoil, as applicable.

3.6 CONTAMINATED MATERIALS

- .1 If contaminated materials are detected during excavation operations, immediately notify the Departmental Representative. Any contaminated materials to be disposed of using methods approved by the Departmental Representative.

3.7 GRADING

- .1 Grade to ensure that water will drain away from buildings, walls and paved areas, to catch basins and other disposal areas approved by Departmental Representative. Grade to be gradual between finished spot elevations as indicated.

3.8 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

- .1 Dispose of cleared and grubbed material off site daily.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 -Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 — Construction/Demolition Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 32 11 16.01 — Granular Sub-Base.
- .2 Section 32 11 23 — Aggregate Base Courses.

1.2 REFERENCE STANDARDS

- .1 ASTM International
 - .1 ASTM D 4791-10, Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
- .2 U.S. Environmental Protection Agency (EPA)/Office of Water
 - .1 EPA 832/R-92-005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for aggregate materials and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Samples:
 - .1 Submit samples in accordance with Section 01 33 00 — Submittal Procedures.
 - .2 Allow continual sampling by Departmental Representative during production.
 - .3 Provide Departmental Representative with access to source and processed material for sampling.
 - .4 Provide front end loader or other suitable equipment including trained operator for stockpile sampling as necessary. Move samples to storage place as directed by Departmental Representative.
 - .5 Supply new or clean sample bags or containers according appropriate to aggregate materials.
 - .6 Pay cost of sampling and testing of aggregates which fail to meet specified requirements.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Transportation and Handling: handle and transport aggregates to avoid segregation, contamination and degradation.

- .3 Storage: store washed materials or materials excavated from underwater 24 hours minimum to allow free water to drain and for materials to attain uniform water content.

Part 2 Products

2.1 MATERIALS

- .1 Aggregate quality: sound, hard, durable material free from soft, thin, elongated or laminated particles, organic material, clay lumps or minerals, free from adherent coatings and injurious amounts of disintegrated pieces or other deleterious substances.
- .2 Flat and elongated particles of coarse aggregate: to ASTM D 4791.
 - .1 Greatest dimension to exceed 5 times least dimension.
- .3 Fine aggregates satisfying requirements of applicable section to be one, or blend of following:
 - .1 Screenings produced in crushing of quarried rock, boulders, gravel or slag.
 - .2 Reclaimed asphalt pavement.
 - .3 Reclaimed concrete material.
 - .4 Coarse aggregates satisfying requirements of applicable section to be one of or blend of following:
 - .1 Crushed rock.
 - .2 Gravel and crushed gravel composed of naturally formed particles of stone.
 - .3 Light weight aggregate, including slag and expanded shale.
 - .4 Reclaimed asphalt pavement.
 - .5 Reclaimed concrete material.

2.2 SOURCE QUALITY CONTROL

- .1 Inform Departmental Representative of proposed source of aggregates and provide access for sampling 4 weeks minimum before starting production.
- .2 If materials from proposed source do not meet, or cannot reasonably be processed to meet, specified requirements, locate alternative source.
- .3 Advise Departmental Representative 4 weeks minimum in advance of proposed change of material source.
- .4 Acceptance of material at source does not preclude future rejection if it fails to conform to requirements specified, lacks uniformity, or if its field performance is found to be unsatisfactory.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions are acceptable for topsoil stripping.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with topsoil stripping only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 PREPARATION

- .1 Aggregate source preparation:
 - .1 Prior to excavating materials for aggregate production, clear and grub area to be worked, and strip unsuitable surface materials. Dispose of cleared, grubbed and unsuitable materials as approved by authority having jurisdiction.
 - .2 Where clearing is required, leave screen of trees between cleared area and roadways as directed.
 - .3 Clear, grub and strip area ahead of quarrying or excavating operation sufficient to prevent contamination of aggregate by deleterious materials.
 - .4 When excavation is completed dress sides of excavation to nominal 1.5:1 slope, and provide drains or ditches as required to prevent surface standing water.
 - .5 Trim off and dress slopes of waste material piles and leave site in neat condition.
 - .6 Provide silt fence or other means to prevent contamination of existing watercourse or natural wetland features.
- .2 Processing:
 - .1 Process aggregate uniformly using methods that prevent contamination, segregation and degradation.
 - .2 Blend aggregates, as required, including reclaimed materials that meet physical requirements of specification is permitted in order to satisfy gradation requirements for material and, percentage of crushed particles, or particle shapes specified.
 - .1 Use methods and equipment approved in writing by Departmental Representative.
- .3 When operating in stratified deposits use excavation equipment and methods that produce uniform, homogeneous aggregate gradation.
- .4 Where necessary, screen, crush, wash, classify and process aggregates with suitable equipment to meet requirements.

- .1 Use only equipment approved in writing by Departmental Representative.
- .5 Stockpiling:
 - .1 Stockpile aggregates on site in locations as indicated unless directed otherwise by Departmental Representative. Do not stockpile on completed pavement surfaces.
 - .2 Stockpile aggregates in sufficient quantities to meet project schedules.
 - .3 Stockpiling sites to be level, well drained, and of adequate bearing capacity and stability to support stockpiled materials and handling equipment.
 - .4 Except where stockpiled on acceptably stabilized areas, provide compacted sand base not less than 300 mm in depth to prevent contamination of aggregate. Stockpile aggregates on ground but do not incorporate bottom 300 mm of pile into Work.
 - .5 Separate different aggregates by strong, full depth bulkheads, or stockpile far enough apart to prevent intermixing.
 - .6 Do not use intermixed or contaminated materials. Remove and dispose of rejected materials as directed by Departmental Representative within 48 hours of rejection.
 - .7 Stockpile materials in uniform layers of thickness as follows:
 - .1 Maximum 1.5 in for coarse aggregate and base course materials.
 - .2 Maximum 1.5 m for fine aggregate and sub-base materials.
 - .3 Maximum 1.5 m for other materials.
 - .8 Uniformly spot-dump aggregates delivered to stockpile in trucks and build up stockpile as specified.
 - .9 Do not cone piles or spill material over edges of piles.
 - .9 Do not use conveying stackers.
 - .10 During winter operations, prevent ice and snow from becoming mixed into
 - .11 stockpile or in material being removed from stockpile.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Leave aggregate stockpile site in tidy, well drained condition, free of standing surface water.
- .4 Leave any unused aggregates in neat compact stockpiles as directed by Departmental Representative.
- .5 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

- .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.
- .6 For temporary or permanent abandonment of aggregate source, restore source to condition meeting requirements of authority having jurisdiction.
- .7 Restrict public access to temporary or permanently abandoned stockpiles by means acceptable to Departmental Representative.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 35 29.06 - Health and Safety Requirements
- .2 Section 01 35 43 - Environmental Procedures
- .3 Section 01 74 21 — Construction/Demolition Waste Management and Disposal
- .4 Section 31 23 33.01 — Excavating, Trenching, and Backfilling.

1.2 DEFINITIONS

- .1 Clearing consists of cutting off trees and brush vegetative growth to not more than specified height above ground and disposing of felled trees, previously uprooted trees and stumps, and surface debris.
- .2 Close-cut clearing consists of cutting off standing trees, brush, scrub, roots, stumps and embedded logs, removing at, or close to, existing grade and disposing of fallen timber and surface debris.
- .3 Clearing isolated trees consists of cutting off to not more than specified height above ground of designated trees, and disposing of felled trees and debris.
- .4 Underbrush clearing consists of removal from treed areas of undergrowth, deadwood, and trees smaller than 50 mm trunk diameter and disposing of fallen timber and surface debris.
- .5 Grubbing consists of excavation and disposal of stumps and roots boulders and rock fragments of specified size to not less than specified depth below existing ground surface.
- .6 EAB refers to Emerald Ash Borer a non-native, invasive beetle that is highly destructive to ash trees where it occurs.
- .7 Woodchips in the context of EAB consist of untreated, raw bark and wood fragments broken or shredded from logs or branches. Woodchips are to be less than 2.5 cm in at least any two dimensions.
- .8 Firewood in the context of EAB consists of non-manufactured, solid wood material, with or without bark, cut into sizes less than 1.2 metres long and less than 25 cm in diameter which may be handled manually.
- .9 Logs in the context of EAB consist of untreated, raw wood greater than 1.2 metres in length and greater than 25 cm diameter.
- .10 Enclosed vehicle in the context of EAB consist of any vehicle transporting regulated wood material that is equipped to preclude the loss of materials or the escape of EAB while in transit.

1.3 STORAGE AND PROTECTION

- .1 Prevent damage to trees, shrubs, landscaping, natural features, bench marks, existing buildings, existing pavement, utility lines, site appurtenances, water courses, and root systems of trees which are to remain.
 - .1 Repair damaged items to approval of Departmental Representative.
- .2 Replace trees designated to remain, if damaged, as directed by Departmental Representative.

1.4 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 — Construction/Demolition Waste Management and Disposal.
- .2 Consider felled timber from which saw logs, pulpwood, posts, poles, ties, or fuel wood can be produced as saleable timber.
 - .1 Trim limbs and tops, and saw into saleable lengths.
 - .2 Stockpile adjacent to site.

Part 2 Products

2.1 NOTUSED

- .1 Not used.

Part 3 Execution

3.1 PREPARATION

- .1 Inspect site and verify with Departmental Representative, items designated to remain.
- .2 Locate and protect utility lines: preserve in operating condition active utilities traversing site.
 - .1 Notify Departmental Representative immediately of damage to or when unknown existing utility lines are encountered.
 - .2 When utility lines which are to be removed are encountered within area of operations, notify Departmental Representative in ample time to minimize interruption of service.
- .3 Notify utility authorities before starting clearing and grubbing.
- .4 Keep roads and walks free of dirt and debris.

3.2 APPLICATION

- .1 Manufacturer's instructions: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.3 CLEARING

- .1 Clearing includes felling, trimming, and cutting of trees into sections and satisfactory disposal of trees and other vegetation designated for removal, including downed timber, snags, brush, and rubbish occurring within cleared areas.
- .2 Clear as indicated on Contract Drawings and/or by Departmental Representative, by cutting at height of not more than 300 mm above ground. In areas to be subsequently grubbed, height of stumps left from clearing operations to be not more than 1000 mm above ground surface.
- .3 Cut off branches and cut down trees overhanging area cleared as directed by Departmental Representative.
- .4 Cut off unsound branches on trees designated to remain as directed by Departmental Representative.

3.4 CLOSE CUT CLEARING

- .1 Close cut clearing to ground level.
- .2 Perform close cut clearing by hand so that existing muskeg is not damaged.
- .3 Cut off branches and cut down trees overhanging area cleared as directed by Departmental Representative.
- .4 Cut off unsound branches on trees designated to remain as directed by Departmental Representative.

3.5 ISOLATED TREES

- .1 Cut off isolated trees as directed by Departmental Representative at height of not more than 300mm above ground surface.
- .2 Grub out isolated tree stumps.
- .3 Prune individual trees as indicated.
- .4 Cut limbs and branches to be trimmed close to bole of tree or main branches.

3.6 UNDERBRUSH CLEARING

- .1 Clear underbrush from areas as indicated at ground level.

3.7 GRUBBING

- .1 Remove and dispose of roots larger than 7.5 cm in diameter, matted roots, and designated stumps from indicated grubbing areas.

- .2 Grub out stumps and roots to not less than 200 mm below ground surface.
- .3 Grub out visible rock fragments and boulders, greater than 300 mm in greatest dimension, but less than 0.25 m^{id}
- .4 Fill depressions made by grubbing with suitable material and to make new surface conform to existing adjacent surface of ground.

3.8 REMOVAL AND DISPOSAL

- .1 Remove cleared and grubbed materials and transport to storage area as directed by Departmental Representative.
- .2 Chip and stockpile cleared and grubbed vegetative material on site as directed by Departmental Representative.
 - .1 Authorization from Departmental Representative required prior to chipping activities commencing.
- .3 Cut timber greater than 125 mm diameter to 3000 mm lengths and stockpile as directed by Departmental Representative. Unless otherwise notified, stockpiled timber becomes property of Departmental Representative.
- .4 Dispose of cleared and grubbed materials by unable to be chipped offsite as directed by Departmental Representative.
- .5 Remove diseased trees identified by Departmental Representative and dispose of this material to approval of Departmental Representative.

3.9 FINISHED SURFACE

- .1 Leave ground surface in condition suitable for immediate maintenance vehicle access to approval of Departmental Representative.

3.10 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, flagging tape, tools and equipment.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 02 41 99 — Demolition for Minor Works.
- .2 Section 33 05 13.01 — Oil Silt Separator - Storm Treatment Device.
- .3 Section 33 05 16 — Maintenance Holes and Catch Basin Structures.
- .4 Section 33 11 16 — Site Water Utility Distribution Piping.
- .5 Section 33 31 13 — Public Sanitary Utility Sewerage Piping.
- .6 Section 33 41 00 — Storm Utility Drainage Piping.

1.2 REFERENCE STANDARDS

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM C 117-04, Standard Test Method for Material Finer than 0.075 mm (No.200) Sieve in Mineral Aggregates by Washing.
 - .2 ASTM C 136-05, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .3 ASTM D 422-63 2002, Standard Test Method for Particle-Size Analysis of Soils.
 - .4 ASTM D 698-00ae1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ ³) (600 kN-m ³)
 - .5 ASTM D 1557-02e1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ ³) (2,700 kN-m ³)
 - .6 ASTM D 4318-05, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.
- .3 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-A3000-[03], Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).
 - .1 CSA-A3001-[03], Cementitious Materials for Use in Concrete.
 - .2 CSA-A23.1/A23.2-[04], Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.

1.3 DEFINITIONS

- .1 Excavation classes: two classes of excavation will be recognized; common excavation and rock excavation.
 - .1 Rock: solid material in excess of 1.0 m^d and which cannot be removed by means of heavy duty mechanical excavating equipment with 0.95 to 1.15 m³ bucket. Frozen material not classified as rock.

- .2 Common excavation: excavation of materials of whatever nature, which are not included under definitions of rock excavation.
- .2 Unclassified excavation: excavation of deposits of whatever character encountered in Work.
- .3 Topsoil:
 - .1 Material capable of supporting good vegetative growth and suitable for use in top dressing, landscaping and seeding.
 - .2 Material reasonably free from subsoil, clay lumps, brush, objectionable weeds, and other litter, and free from cobbles, stumps, roots, and other objectionable material larger than 25 millimeters in any dimension.
- .4 Waste material: excavated material unsuitable for use in Work or surplus to requirements.
- .5 Borrow material: material obtained from locations outside area to be graded, and required for construction of fill areas or for other portions of Work.
- .6 Recycled fill material: material, considered inert, obtained from alternate sources and engineered to meet requirements of fill areas.
- .7 Unsuitable materials:
 - .1 Weak, chemically unstable, and compressible materials.
 - .2 Frost susceptible materials:
 - .1 Fine grained soils with plasticity index less than 10 when tested to ASTM D 4318, and gradation within limits specified when tested to ASTM D 422 and ASTM C 136: Sieve sizes to CAN/CGSB-8.2.
 - .2 Table:

Sieve Designation	% Passing
2.00mm	100
0.10mm	45-100
0.02mm	10-80
0.005mm	0-45
 - .3 Coarse grained soils containing more than 20% by mass passing 0.075 mm sieve.
 - .8 Unshrinkable fill: very weak mixture of cement, concrete aggregates and water that resists settlement when placed in utility trenches, and capable of being readily excavated.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Quality Control: in accordance with Section 01 45 00 - Quality Control:

- .1 Submit condition survey of existing conditions as described in EXISTING CONDITIONS article of this Section. (Section 31 23 33.01 —Excavating, Trenching, and Backfilling)
- .2 Submit for review by Departmental Representative proposed dewatering and heave prevention methods as described in PART 3 of this Section. (Section 31 23 33.01 —Excavating, Trenching, and Backfilling)
- .3 Submit to Departmental Representative written notice at least 7 days prior to excavation work, to ensure cross sections are taken.
- .4 Submit to Departmental Representative written notice when bottom of excavation is reached.
- .5 Submit to Departmental Representative testing and inspection results and reports as described in PART 3 of this Section. (Section 31 23 33.01 —Excavating, Trenching, and Backfilling)
- .3 Preconstruction Submittals:
 - .1 Submit construction equipment list for major equipment to be used in this section prior to start of Work.
 - .2 Submit records of underground utility locates, indicating: location plan of existing utilities as found in field and location plan of relocated and abandoned services, as required.
- .4 Samples:
 - .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Inform Departmental Representative at least 4 weeks prior to beginning Work, of proposed source of fill materials and provide access for sampling.
 - .3 Submit 70 kg samples of type of fill specified including representative samples of excavated material.
 - .4 Ship samples to Departmental Representative, in tightly closed containers to prevent contamination and exposure to elements.
 - .5 At least 4 weeks prior to beginning Work, inform Departmental Representative source of fly ash and submit samples to Departmental Representative.
 - .1 Do not change source of Fly Ash without written approval of Departmental Representative.

1.5 QUALITY ASSURANCE

- .1 Qualification Statement: submit proof of insurance coverage for professional liability.
- .2 Where Departmental Representative is employee of Contractor, submit proof that Work by Departmental Representative is included in Contractor's insurance coverage.
- .3 Submit design and supporting data at least 2 weeks prior to beginning Work.
- .4 Design and supporting data submitted to bear stamp and signature of qualified professional engineer registered or licensed in British Columbia, Canada.

- .5 Keep design and supporting data on site.
- .6 Engage services of qualified professional Engineer who is registered or licensed in British Columbia, Canada in which Work is to be carried out to design and inspect cofferdams, shoring, bracing and underpinning required for Work.
- .7 Do not use soil material until written report of soil test results are reviewed and approved by Departmental Representative.
- .8 Health and Safety Requirements:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 — Construction/Demolition Waste Management and Disposal.
- .2 Divert excess aggregate materials from landfill to local facility for reuse as directed by Departmental Representative.

1.7 EXISTING CONDITIONS

- .1 Examine soil reports.
- .2 Buried services:
 - .1 Before commencing work verify location of buried services on and adjacent to site.
 - .2 Arrange with appropriate authority for relocation of buried services that interfere with execution of work: pay costs of relocating services.
 - .3 Remove obsolete buried services within 2 m of foundations: cap cut-offs.
 - .4 Size, depth and location of existing utilities and structures as indicated are for guidance only. Completeness and accuracy are not guaranteed.
 - .5 Confirm locations of buried utilities by careful test excavations or soil hydro vac methods.
 - .6 Maintain and protect from damage, water, sewer, gas, electric, telephone and other utilities and structures encountered.
 - .7 Where utility lines or structures exist in area of excavation, obtain direction of Departmental Representative before removing, re-routing.
 - .8 Record location of maintained, re-routed and abandoned underground lines.
 - .9 Confirm locations of recent excavations adjacent to area of excavation.
- .3 Existing buildings and surface features:
 - .1 Conduct, with Departmental Representative, condition survey of existing buildings, trees and other plants, lawns, fencing, service poles, wires, rail tracks, pavement, survey bench marks and monuments which may be affected by Work.

- .2 Protect existing buildings and surface features from damage while Work is in progress. In event of damage, immediately make repair as directed by Departmental Representative.
- .3 Where required for excavation, cut roots or branches as directed by Departmental Representative.

Part 2 Products

2.1 MATERIALS

- .1 Type 1 and Type 2 fill: properties to Section 31 05 16-Aggregate Materials and the following requirements:
 - .1 Crushed, pit run or screened stone, gravel or sand.
 - .2 Gradations to be within limits specified when tested to ASTM C 136 and ASTM C 117. Sieve sizes to CAN/CGSB-8.2.
 - .3 Table:

Sieve Designation !)	% Passing	
	Type 1	Type 2
75		100
50		
37.5		
2	100	
19	75-100	
12.5	-	-
9.5	50-100	-
4.75	30-75	22-85
2.00	20-45	
0.425	10-25	5-30
0.180		
0.075	3-8	0-10

- .2 Type 3 fill: selected material from excavation or other sources, approved by Departmental Representative for use intended, unfrozen and free from rocks larger than 75 mm, cinders, ashes, sods, refuse or other deleterious materials.

Part 3 Execution

3.1 SITE PREPARATION

- .1 Remove obstructions, ice and snow, from surfaces to be excavated within limits indicated.
- .2 Cut pavement or sidewalk neatly along limits of proposed excavation in order that surface may break evenly and cleanly.

3.2 PREPARATION/PROTECTION

- .1 Protect existing features in accordance with Section 01 56 00 - Temporary Barriers and Enclosures and applicable local regulations.
- .2 Keep excavations clean, free of standing water, and loose soil.
- .3 Where soil is subject to significant volume change due to change in moisture content, cover and protect to Departmental Representative approval.
- .4 Protect natural and man-made features required to remain undisturbed. Unless otherwise indicated or located in an area to be occupied by new construction, protect existing trees from damage.
- .5 Protect buried services that are required to remain undisturbed.

3.3 STRIPPING OF TOPSOIL

- .1 Begin topsoil stripping of areas as indicated by Contract Drawings and/or Departmental Representative after area has been cleared of brush, weeds, and grasses and removed from site.
- .2 Strip topsoil to depths as directed by Departmental Representative.
 - .1 Do not mix topsoil with subsoil.
- .3 Stockpile in locations as directed by Departmental Representative.
 - .1 Stockpile height not to exceed 2 m and should be protected from erosion.
- .4 Dispose of unused topsoil as directed by Departmental Representative.

3.4 STOCKPILING

- .1 Stockpile fill materials in areas designated by Departmental Representative.
 - .1 Stockpile granular materials in manner to prevent segregation.
- .2 Protect fill materials from contamination.
- .3 Implement sufficient erosion and sediment control measures to prevent sediment release off construction boundaries and into water bodies.

3.5 COFFERDAMS, SHORING, BRACING AND UNDERPINNING

- .1 Maintainsides and slopes of excavations in safe condition by appropriate methods and in accordance with Section 01 35 29.06 - Health and Safety Requirements
 - .1 Where conditions are unstable, Departmental Representative to verify and advise methods.
- .2 Obtain permit from authority having jurisdiction for temporary diversion of water course.
- .3 Construct temporary Works to depths, heights and locations as approved by Departmental Representative.
- .4 During backfill operation:
 - .1 Unless otherwise indicated or directed by Departmental Representative, remove sheeting and shoring from excavations.
 - .2 Do not remove bracing until backfilling has reached respective levels of such bracing.
 - .3 Pull sheeting in increments that will ensure compacted backfill is maintained at elevation at least 500 mm above toe of sheeting.
- .5 When sheeting is required to remain in place, cut off tops at elevations as indicated.
- .6 Upon completion of substructure construction:
 - .1 Remove cofferdams, shoring and bracing.
 - .2 Remove excess materials from site and restore watercourses in accordance with Section 35 42 19 — Preservation of Water Courses and Wetlands.

3.6 DEWATERING AND HEAVE PREVENTION

- .1 Keep excavations free of water while Work is in progress.
- .2 Provide for Departmental Representative review and approval details of proposed dewatering or heave prevention methods, including dikes, well points, and sheet pile cut-offs.
- .3 Avoid excavation below groundwater table if quick condition or heave is likely to occur.
 - .1 Prevent piping or bottom heave of excavations by groundwater lowering, sheet pile cut-offs, or other means.
- .4 Protect open excavations against flooding and damage due to surface run-off.
- .5 Dispose of water in accordance with Section 01 35 43 - Environmental Procedures to approved collection areas and in a manner not detrimental to public and private property, or portion of Work completed or under construction.
 - .1 Provide and maintain temporary drainage ditches and other diversions outside of excavation limits.

- .6 Provide flocculation tanks, settling basins, or other treatment facilities to remove suspended solids or other materials before discharging to storm sewers, watercourses or drainage areas.

3.7 EXCAVATION

- .1 Advise Departmental Representative at least 7 days in advance of excavation operations for initial cross sections to be taken.
- .2 Excavate to lines, grades, elevations and dimensions as indicated by Contract Drawings.
- .3 Excavation must not interfere with bearing capacity of adjacent foundations.
- .4 Do not disturb soil within branch spread of trees or shrubs that are to remain.
 - .1 If excavating through roots, excavate by hand and cut roots with sharp axe or saw.
- .5 For trench excavation, unless otherwise authorized by Departmental Representative in writing, do not excavate more than 30 m of trench in advance of installation operations and do not leave open more than 15 m at end of day's operation.
- .6 Keep excavated and stockpiled materials safe distance away from edge of trench as directed by Departmental Representative.
- .7 Restrict vehicle operations directly adjacent to open trenches.
- .8 Dispose of surplus and unsuitable excavated material in approved location on site.
- .9 Do not obstruct flow of surface drainage or natural watercourses.
- .10 Earth bottoms of excavations to be undisturbed soil, level, free from loose, soft or organic matter.
- .11 Obtain Departmental Representative approval of completed excavation.
- .12 Remove unsuitable material from trench bottom including those that extend below required elevations to extent and depth as directed by Departmental Representative.
- .13 Correct unauthorized over-excavation as follows:
 - .1 Fill under bearing surfaces and footings with concrete specified for footings Type 2 fill compacted to not less than 100% of corrected Standard Proctor maximum dry density.
 - .2 Fill under other areas with Type 2 fill compacted to not less than 95% of corrected Standard Proctor maximum dry density.
- .14 Hand trim, make firm and remove loose material and debris from excavations.
 - .1 Where material at bottom of excavation is disturbed, compact foundation soil to density at least equal to undisturbed soil.
 - .2 Clean out rock seams and fill with concrete mortar or grout to approval of Departmental Representative.

3.8 FILL TYPES AND COMPACTION

- .1 Use types of fill as indicated or specified below. Compaction densities are percentages of maximum densities obtained from ASTM D1557.
 - .1 Under concrete slabs: in accordance with Contract Drawings. Compact base course to 100%.
 - .2 Retaining walls: use Type 2 fill to subgrade level on high side for minimum 500 mm from wall and compact to 95%. For remaining portion, use Type 3 fill compacted to 95%.
 - .3 Place unshrinkable fill in areas as indicated.

3.9 BEDDING AND SURROUND OF UNDERGROUND SERVICES

- .1 Place and compact granular material for bedding and surround of underground services as specified in Section 31 00 99 — Earthwork for Minor Works.
- .2 Place bedding and surround material in unfrozen condition.

3.10 BACKFILLING

- .1 Mechanical vibratory compaction equipment.
- .2 Do not proceed with backfilling operations until completion of following:
 - .1 Departmental Representative has inspected and approved installations.
 - .2 Departmental Representative has inspected and approved of construction below finish grade.
 - .3 Inspection, testing, approval, and recording location of underground utilities.
 - .4 Removal of concrete formwork.
 - .5 Removal of shoring and bracing; backfilling of voids with satisfactory soil material.

Areas to be backfilled to be free from debris, snow, ice, water and frozen ground.
- .3 Do not use backfill material which is frozen or contains ice, snow or debris.
- .4 Place backfill material in uniform layers not exceeding 150 mm compacted thickness up to grades indicated. Compact each layer before placing succeeding layer.
- .5 Backfilling around installations:
 - .1 Place bedding and surround material as specified elsewhere.
 - .2 Do not backfill around or over cast-in-place concrete within 24 hours after placing of concrete.
 - .3 Place layers simultaneously on both sides of installed Work to equalize loading.
 - .4 Where temporary unbalanced earth pressures are liable to develop on walls or other structures:

- .1 Permit concrete to cure for minimum 14 days or until it has sufficient strength to withstand earth and compaction pressure and approval obtained from Departmental Representative or:
- .2 If approved by Departmental Representative, erect bracing or shoring to counteract unbalance, and leave in place until removal is approved by Departmental Representative.
- .7 Place recycled fill in areas as indicated,
- .8 Consolidate and level unshrinkable fill with internal vibrators.
- .9 Install drainage system in backfill as directed by Departmental Representative.

3.11 RESTORATION

- .1 Upon completion of Work, remove waste materials and debris in accordance to Section 01 74 21 — Construction/Demolition Waste Management and Disposal, trim slopes, and correct defects as directed by Departmental Representative.
- .2 Replace topsoil as directed by Departmental Representative.
- .3 Reinstall lawns to elevation which existed before excavation.
- .4 Reinstall pavements disturbed by excavation to thickness, structure and elevation which existed before excavation.
- .5 Clean and reinstall areas affected by Work as directed by Departmental Representative.
- .6 Use temporary plating to support traffic loads over unshrinkable fill for initial 24 hours.
- .7 Protect newly graded areas from traffic and erosion and maintain free of trash or debris.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation of polymeric geotextiles used in revetments, breakwaters, retaining wall structures, filtration, drainage structures, roadbeds and railroad beds purpose of which is to:
 - .1 Separate and prevent mixing of granular materials of different grading.
 - .2 Act as hydraulic filters permitting passage of water while retaining soil strength of granular structure.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 — Submittal Procedures.
- .2 Section 01 74 21 — Construction/Demolition Waste Management and Disposal.
- .3 Section 31 00 99 — Earthworks for Minor Works.
- .4 Section 31 37 00 — Rip-Rap.

1.3 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM):
 - .1 ASTM D4491-99a(2009), Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
 - .2 ASTM D4595-09, Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
 - .3 ASTM D4716-08(2013), Test Method for Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head.
 - .4 ASTM D4751-12, Standard Test Method for Determining Apparent Opening Size of a Geotextile.
- .2 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-4.2 No. 11.2-M89(April 1997), Textile Test Methods - Bursting Strength - Ball Burst Test (Extension of September 1989).
 - .2 CAN/CGSB-148.1, Methods of Testing Geotextiles and Complete Geomembranes.
 - .1 No.2-M85, Methods of Testing Geosynthetics - Mass per Unit Area.
 - .2 No.3-M85, Methods of Testing Geosynthetics - Thickness of Geotextiles.
 - .3 No.6.1-93, Methods of Testing Geotextiles and Geomembranes - Bursting Strength of Geotextiles Under No Compressive Load.
 - .4 No.7.3-92, Methods of Testing Geotextiles and Geomembranes - Grab Tensile Test for Geotextiles.

- .5 No. 10-94, Methods of Testing Geosynthetics - Geotextiles - Filtration Opening Size.
- .3 Canadian Standards Association (CSA International):
 - .1 CAN/CSA-G40.20/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .2 CAN/CSA-G164-M92(R2003), Hot Dip Galvanizing of Irregularly Shaped Articles.
- .4 Ontario Provincial Standard Specifications (OPSS):
 - .1 OPSS 1860-[March 1998], Material Specification for Geotextiles.
- .5 British Columbia Ministry of Health — British Columbia Onsite Sewage Association:
 - .1 Sewerage System Standard Practice Manual — Version 2, 21 September, 2007.

1.4 SUBMITTALS

- .1 Submit to Departmental Representative 3 copies of mill test data and certificate at least 4 weeks prior to start of Work, and in accordance with Section 01 33 00 - Submittal Procedures.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 During delivery and storage, protect geotextiles from direct sunlight, ultraviolet rays, excessive heat, mud, dirt, dust, debris and rodents.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

Part 2 Products

2.1 MATERIAL

- .1 Geotextile: non-woven synthetic fibre fabric, supplied in rolls:
 - .1 Width: 2 in minimum.
 - .2 Length: 200 m minimum.
 - .3 Composed of: minimum 85% by mass of polypropylene with inhibitors added to base plastic to resist deterioration by ultra-violet and heat exposure for 60 days.
- .2 Physical properties:
 - .1 Thickness: to CAN/CGSB-148.1, No.3, minimum 1.2 mm.
 - .2 Mass per unit area: to CAN/CGSB-148.1, No.2, minimum 155 g/m².

- .3 Grab tensile strength and elongation: to ASTM D4632.
 - .1 Breaking force: minimum 35 lb, wet condition.
 - .2 Elongation at future: minimum 50%.
- .4 Puncture; to ASTM D4833: 10 lbs minimum.
- .5 Trapezoidal tear; to ASTM D4533: 11 lbs minimum.
- .3 Hydraulic properties:
 - .1 Apparent opening size (AOS): to ASTM D4751, US Sive #20 minimum and 70 maximum.
 - .2 Permittivity: to ASTM D4491, 100 gal/min/sq ft minimum.
- .4 Securing pins and washers: to CAN/CSA-G40.21, Grade 300W, hot-dipped galvanized with minimum zinc coating of 600 g/m² to CAN/CSA G164.

Part 3 Execution

3.1 INSTALLATION

- .1 Place geotextile material by unrolling onto graded surface in orientation, manner and locations indicated.
- .2 Place geotextile material smooth and free of tension stress, folds, wrinkles and creases.
- .3 Place geotextile material on sloping surfaces in one continuous length from toe of slope to upper extent of geotextile.
- .4 Overlap each successive strip of geotextile 600 mm over previously laid strip.
- .5 Protect installed geotextile material from displacement, damage or deterioration before, during and after placement of material layers.
- .6 After installation, cover with overlying layer within 4 h of placement.
- .7 Replace damaged or deteriorated geotextile to approval of Departmental Representative.
- .8 Place and compact soil layers in accordance with Section 31 00 99 — Earthworks for Minor Works.

3.2 CLEANING

- .1 Remove construction debris from Project site and dispose of debris in an environmentally responsible and legal manner.

3.3 PROTECTION

- .1 Vehicular traffic not permitted directly on geotextile.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 31 00 99 - Earthworks for Minor Works.
- .2 Section 31 32 19.01 — Geotextiles.

1.2 REFERENCE STANDARDS

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM C 144-99, Standard Specification for Aggregate for Masonry Mortar.
 - .2 ASTM C 618-00, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
- .2 Canadian Standards Association (CSA)
 - .1 CAN/CSA-A23.1-00, Concrete Materials and Methods of Concrete Construction.
 - .2 CAN/CSA-A3000-98, Cementations Materials Compendium.

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 — Construction/Demolition Waste Management and Disposal.
- .2 Place materials defined as hazardous or toxic in designated containers.
- .3 Fold up metal banding, flatten and place in designated area for recycling.
- .4 Divert left over aggregate materials from landfill to local facility for reuse as approved by Departmental Representative.
- .5 Divert left over hardened cement materials from landfill to local facility for reuse as approved by Departmental Representative.
- .6 Divert left over geotextiles to local plastic recycling facility as approved by Departmental Representative.

Part 2 Products

2.1 RIP-RAP

- .1 Riprap shall consist of clean, free draining, sound dense, durable crushed rock; free of organics, roots, silt, sand, clay, snow, ice, or other deleterious material.
- .2 Dense, sound, hard and durable fieldstone or quarried rock fragments. Quarried rock fragments shall have a specific gravity of at least 2.6 and a limit of 2% absorption.
- .3 Rock shall be hard white durable limestone or dolomite with the following properties:
 - .1 Minimum bulk specific gravity of 2.6 (ASTM C 127).
 - .2 Maximum Los Angeles abrasion loss of 35% (ASTM C 131).

- .3 Maximum soundness loss of 18% (ASTM C88).
 - .4 Maximum absorption of 2.5% (ASTM C127).
- Rip rap to meet following size distribution for use intended:

Canadian Metric Sieve Size	% of Total Dry Weight Passing Each Sieve
400mm	100
250mm	40-60
50mm	0-5

2.2 CEMENT MORTAR

- .1 Cement: to CAN/CSA-A3000, type 10.
- .2 Sand for mortar: to ASTM C 144.
- .3 Mortar mix: 1 part by volume of cement to 3 parts sand, to consistency approved by Departmental Representative.

2.3 GEOTEXTILE FILTER

- .1 Geotextile soil stabilization: in accordance with Section 31 32 19.16 - Geotextile soil stabilization.

Part 3 Execution

3.1 GENERAL

- .1 Prior to commencing rip-rap Works, eliminate uneven areas and depressions on the area to be rip-rapped by fine grading to a uniform even surface. Fill depressions with suitable material and compact to provide firm bed.
- .2 Obtain Departmental Representative approval of finish slope prior to proceeding with rip-rap placement.

3.2 STOCKPILING

- .1 Temporarily stockpile all sand, gravel, and rock materials that have been processed by washing methods for a minimum of 48 hours to permit drainage of excess water. Do not place recently washed materials on top of or with drier stockpiled materials.
- .2 Use equipment and methods that minimizes the amount of material handling, and that do not cause segregation or material breakdown.
- .3 Do not stockpile materials where contamination with the underlying soils can occur.

3.3 PLACING

- .1 Place rip-rap as indicated on Contract Drawings.
- .2 Machine place. Do not dump at top of slope and spread.
- .3 Intermix the rip rap material to uniformly distribute the larger size material and utilize small size material to fill in the void spaces resulting in a well -keyed, void free, stable surface with a consistent gradation. Ensure the segregation does not occur during placement.
- .4 Do not dislodge or tear geotextile fabric during the placement of rip- rap. Repair as an incidental to the Works.
- .5 Ensure the completed rip-rap placed is stable with no tendency to slide.
- .6 Hand place as required to provide a neat and uniform surface.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 ASTM International
 - .1 ASTM C 117-04, Standard Test Methods for Material Finer Than 0.075 mm Sieve in Mineral Aggregates by Washing,
 - .2 ASTM C 131-06, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - .3 ASTM C 136-06, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .4 ASTM D 422-63(2007), Standard Test Method for Particle-Size Analysis of Soils.
 - .5 ASTM D 698-07e1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400ft-lbf/IU) (600kN-m/mu).
 - .6 ASTM D 1557-09, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000ft-lbf/IU) (2,700kN-m/md).
 - .7 ASTM D 1883-07e2, Standard Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.
 - .8 ASTM D 4318-10, Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series.
 - .2 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.
- .3 U.S. Environmental Protection Agency (EPA) / Office of Water
 - .1 EPA 832/R-92-005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Sustainable Design Submittals:
 - .1 Erosion and Sedimentation Control: submit copy of erosion and sedimentation control plan in accordance with EPA 832/R-92-2005 and authorities having jurisdiction.
 - .2 Construction Waste Management:
 - .1 Submit project Waste Management Plan and Waste Reduction Workplan highlighting recycling and salvage requirements.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

- .2 Storage and Handling Requirements:
 - .1 Store materials in accordance with manufacturer's recommendations and erosion and sedimentation control plan.
 - .2 Replace defective or damaged materials with new.
- .3 Develop Construction Waste Management Plan and Waste Reduction Workplan related to Work of this Section.

Part 2 Products

2.1 MATERIALS

- .1 Granular sub-base material: in accordance with Section 31 05 16 - Aggregate Materials and following requirements:
 - .1 Crushed, pit run or screened stone, gravel or sand.
 - .2 Gradations to be within limits specified when tested to ASTM C 136 and ASTM C 117. Sieve sizes to CAN/CGSB-8.2.
 - .3 Table

Sieve Designation	% Passing
75	100
50	
25	----
19	15-100
9.5	0-100
4.75	
1.18	
.600	0-100
.300	0-15
.075	0-5
 - .4 Other properties as follows:
 - .1 Liquid Limit: to ASTM D 4318, Maximum 25.
 - .2 Plasticity Index: to ASTM D 4318, Maximum 6.
 - .3 Los Angeles degradation: to ASTM C 131.
 - .1 Maximum loss by mass: 50%,
 - .4 Particles smaller than 0.02 mm: to ASTM D 422, Maximum 3%.
 - .5 Soaked CBR: to ASTM D 1883, Minimum 40 when compacted to 100% of ASTM D 1557.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrate previously installed under other Sections or Contracts are acceptable for granular sub-base installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 PREPARATION

- .1 Temporary Erosion and Sedimentation Control:
 - .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction, sediment and erosion control drawings, sediment and erosion control plan, specific to site, that complies with EPA 832/R-92-005 or requirements of authorities having jurisdiction, whichever is more stringent.
 - .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
 - .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

PLACEMENT AND INSTALLATION

3.3

- .1 Place granular sub-base after subgrade is inspected and approved by Departmental Representative.

Placing:

 - .2
 - .1 Construct granular sub-base to depth and grade in areas indicated.
 - .2 Ensure no frozen material is placed.
 - .3 Place material only on clean unfrozen surface, free from snow or ice.
 - .4 Begin spreading sub-base material on crown line or high side of one-way slope.
 - .5 Place granular sub-base materials using methods which do not lead to segregation or degradation.
 - .6 For spreading and shaping material, use spreader boxes having adjustable templates or screeds which will place material in uniform layers of required thickness.

- .7 Place material to full width in uniform layers not exceeding 150 mm compacted thickness.
 - .1 Departmental Representative may authorize thicker lifts if specified compaction can be achieved.
- .8 Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.
- .9 Remove and replace portion of layer in which material has become segregated during spreading.
- .3 Compacting:
 - .1 Compact to density not less than 100% corrected maximum dry density ASTM D 698.
 - .2 Shape and roll alternately to obtain smooth, even and uniformly compacted base.
 - .3 Apply water as necessary during compacting to obtain specified density.
 - .4 In areas not accessible to rolling equipment, compact to specified density with mechanical tampers approved in writing by Departmental Representative.
 - .5 Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.
- .4 Proof rolling:
 - .1 For proof rolling use standard roller of 45400 kg gross mass with four pneumatic tires each carrying 11350 kg and inflated to 620 kPa. Four tires arranged abreast with centre to centre spacing of 730 mm.
 - .2 Obtain written approval from Departmental Representative to use non-standard proof rolling equipment.
 - .3 Proof roll at level in granular base as indicated.
 - .1 If use of non-standard proof rolling equipment is approved, Departmental Representative to determine level of proof rolling.
 - .4 Make sufficient passes with proof roller to subject every point on surface to three separate passes of loaded tire.
 - .5 Where proof rolling reveals areas of defective subgrade:
 - .1 Remove base, sub-base and subgrade material to depth and extent as directed by Departmental Representative.
 - .2 Backfill excavated subgrade with sub-base material and compact in accordance with this Section.
 - .3 Replace sub-base material and compact in accordance with Section.
 - .4 Replace base material and compact in accordance with this Section.
 - .6 Where proof rolling reveals defective base or sub-base, remove defective materials to depth and extent as directed by Departmental Representative and replace with new materials in accordance with this Section at no extra cost.

3.4 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.5 SITE TOLERANCES

- .1 Finished sub-base surface to be within 20 mm of elevation as indicated but not uniformly high or low.

3.6 PROTECTION

- .1 Maintain finished sub-base in condition conforming to this section until succeeding base is constructed, or until granular sub-base is accepted by Departmental Representative.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 ASTM International
 - .1 ASTM C 117-04, Standard Test Methods for Material Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.
 - .2 ASTM C 131-06, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - .3 ASTM C 136-06, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .4 ASTM D 698-07e1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400ft-lbf/IU) (600kN-m/mu).
 - .5 ASTM D 1557-09, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000ft-lbf/IU) (2,700kN-m/mu).
 - .6 ASTM D 1883-07e2, Standard Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.
 - .7 ASTM D 4318-10, Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series.
 - .2 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.
- .3 U.S. Environmental Protection Agency (EPA) / Office of Water
 - .1 EPA 832/R-92-005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Erosion and Sedimentation Control: submit copy of erosion and sedimentation control plan in accordance with EPA 832/R-92-2005 and authorities having jurisdiction.
 - .2 Construction Waste Management:
 - .1 Submit project Waste Management Plan and Waste Reduction Workplan highlighting recycling and salvage requirements.
 - .2 Submit calculations on end-of-project recycling rates, salvage rates.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Storage and Handling Requirements:

- .1 Stockpile minimum 50% of total aggregate required prior to beginning operation.
- .2 Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .3 Replace defective or damaged materials with new.
- .4 Store cement in weathertight bins or silos that provide protection from dampness and easy access for inspection and identification of each shipment.
- .3 Develop Construction Waste Management Plan related to Work of this Section.

Part 2 Products

2.1 MATERIALS

- .1 Granular base: material in accordance with Section 3105 16-Aggregate Materials and following requirements:
 - .1 Crushed stone or gravel.
 - .2 Gradations to be within limits specified when tested to ASTM C 136 and ASTM C 117. Sieve sizes to CAN/CGSB-8.2.
 - .1 Gradation Method #1 to:

Sieve Designation (mm)	% Passing		
	(1)	(2)	(3)
25		100	-
19		80100	-
12.5			
9.5	-	50-85	100
4.75	-	35-70	75-100
2.36	-	25-50	50-72
1.18	-	15-35	5-30
.30	-	5-20	
.075	-	0-5	0-10

- .2 Material to level surface depressions to meet gradation (2) limits in accordance with Method #1.
- .3 Material to for beddings to meet gradation (3) limits in accordance with Method #1.
- .4 Liquid limit: to ASTM D 4318, maximum 25.
- .5 Plasticity index: to ASTM D 4318, maximum 6.

- .6 Los Angeles degradation: to ASTM C 131. Max. % loss by weight: 45
- .7 Crushed particles: at least 60% of particles by mass within each of following sieve designation ranges to have at least 1 freshly fractured face. Material to be divided into ranges using methods of ASTM C 136.

Passing	Retained On	
25 mm	to	19.0 mm
19.0 mm	to	4.75 mm

Part 3 Execution

3.1 PREPARATION

- .1 Temporary Erosion and Sedimentation Control:
 - .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction, sediment and erosion control drawings, sediment and erosion control plan, specific to site, that complies with EPA 832/R-92-005 or requirements of authorities having jurisdiction, whichever is more stringent.
 - .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
 - .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.2 PLACEMENT AND INSTALLATION

- .1 Place granular base after sub-base and/or subgrade surface is inspected and approved in writing by Departmental Representative.
- .2 Placing:
 - .1 Construct granular base to depth and grade in areas indicated.
 - .2 Ensure no frozen material is placed.
 - .3 Place material only on clean unfrozen surface, free from snow and ice.
 - .4 Begin spreading base material on crown line or on high side of one-way slope.
 - .5 Place material using methods which do not lead to segregation or degradation of aggregate.
 - .6 For spreading and shaping material, use spreader boxes having adjustable templates or screeds which will place material in uniform layers of required thickness.
 - .7 Place material to full width in uniform layers not exceeding 150 mm compacted thickness.

- .1 Departmental Representative may authorize thicker lifts (layers) if specified compaction can be achieved.
- .8 Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.
- .9 Remove and replace that portion of layer in which material becomes segregated during spreading.
- .3 Compaction Equipment:
 - .1 Ensure compaction equipment is capable of obtaining required material densities.
- .4 Compacting:
 - .1 Compact to density not less than 100% corrected maximum dry density ASTM D 698.
 - .2 Shape and roll alternately to obtain smooth, even and uniformly compacted base.
 - .3 Apply water as necessary during compacting to obtain specified density.
 - .4 In areas not accessible to rolling equipment, compact to specified density with mechanical tampers approved in writing by Departmental Representative.
 - .5 Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.
- .5 Proof rolling:
 - .1 For proof rolling use standard roller of 45400 kg gross mass with four pneumatic tires each carrying 11350 kg and inflated to 620 kPa. Four tires arranged abreast with centre to centre spacing of 730 mm.
 - .2 Obtain written approval from Departmental Representative to use non-standard proof rolling equipment.
 - .3 Proof roll at level in granular base as indicated.
 - .1 If use of non-standard proof rolling equipment is approved, Departmental Representative to determine level of proof rolling.
 - .4 Make sufficient passes with proof roller to subject every point on surface to three separate passes of loaded tire.
 - .5 Where proof rolling reveals areas of defective subgrade:
 - .1 Remove base, sub-base and subgrade material to depth and extent as directed by Departmental Representative.
 - .2 Backfill excavated subgrade with sub-base material and compact in accordance with Section 32 11 16.01 - Granular Sub-Base.
 - .3 Replace sub-base material and compact in accordance with Section 32 11 16.01 - Granular Sub-base.
 - .4 Replace base material and compact in accordance with this Section.

- .6 Where proof rolling reveals defective base or sub-base, remove defective materials to depth and extent as directed by Departmental Representative and replace with new materials in accordance with Section 32 11 16.01 - Granular Sub-base and this section at no extra cost.

3.3 SITE TOLERANCES

- .1 Finished base surface to be within plus or minus 10 mm of established grade and cross section but not uniformly high or low.

3.4 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.
 - .2 Divert unused granular material from landfill to local facility approved by Departmental Representative.

3.5 PROTECTION

- .1 Maintain finished base in condition conforming to this Section until succeeding material is applied or until acceptance by Departmental Representative.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 32 11 23 — Aggregate Base Courses.

1.2 REFERENCE STANDARDS

- .1 American Association of State Highway and Transportation Officials (AASHTO)
 - .1 AASHTO M320-10, Standard Specification for Performance Graded Asphalt Binder.
 - .2 AASHTO R29-02, Standard Specification for Grading or Verifying the Performance Graded of an Asphalt Binder.
 - .3 AASHTO T245-97(2004), Standard Method of Test for Resistance to Plastic flow of Bituminous Mixtures Using Marshall Apparatus.
- .2 Asphalt Institute (AI)
 - .1 AI MS-2-1994 Sixth Edition, Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types.
- .3 ASTM International
 - .1 ASTM C 88-05, Standard Test Method for Soundness of Aggregates by Use of Sodium Sulphate or Magnesium Sulphate.
 - .2 ASTM C 117-04, Standard Test Method for Material Finer Than 0.075mm (No.200) Sieve in Mineral Aggregates by Washing.
 - .3 ASTM C 123-04, Standard Test Method for Lightweight Particles in Aggregate.
 - .4 ASTM C 127-07, Standard Test Method for Specific Gravity and Absorption of Coarse Aggregate.
 - .5 ASTM C 128-07a, Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate.
 - .6 ASTM C 131-06, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - .7 ASTM C 136-06, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .8 ASTM C 207-2006, Standard Specification for Hydrated Lime for Masonry Purposes.
 - .9 ASTM D 995--95b(2002), Standard Specification for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
 - .10 ASTM D 2419-[09], Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
 - .11 ASTM D 3203-94(2005), Standard Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures.

- .12 ASTM D 4791-05e1, Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
- .4 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.1-[88], Sieves Testing, Woven Wire, Inch Series.
 - .2 CAN/CGSB-8.2-[M88], Sieves Testing, Woven Wire, Metric.
- .5 U.S. Environmental Protection Agency (EPA) / Office of Water
 - .1 EPA 832/R-92-005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for asphalt mixes and aggregate and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit viscosity-temperature chart for asphalt cement to be supplied showing either Saybolt Furol viscosity in seconds or Kinematic Viscosity in centistokes, temperature range 105 to 175 degrees C 4 weeks prior to beginning Work.
- .3 Samples:
 - .1 Inform Departmental Representative of proposed source of aggregates and provide access for sampling 4 weeks prior to beginning Work.
 - .2 Submit samples of following materials proposed for use 4 weeks prior to beginning Work.
 - .1 One SL container of asphalt cement.
 - .2 1 kg of hydrated lime.
- .4 Test and Evaluation Reports:
- .5 Certificates:
 - .1 Certification to be marked on pipe.
- .6 Test and Evaluation Reports:
 - .1 Submit manufacturer's test data and certification that asphalt cement meets specification requirements.
 - .2 Submit manufacturer's test data and certification that hydrated lime meets specified requirements.
 - .3 Submit asphalt concrete mix design and trial mix test results to Departmental Representative for approval at least 4 weeks prior to beginning Work.
 - .4 Submit printed record of mix temperatures at end of each day.

- .7 Sustainable Design Submittals:
- .1 Erosion and Sedimentation Control: submit copy of erosion and sedimentation control plan in accordance with EPA 832/R-92-2005, and authorities having jurisdiction.
 - .2 Construction Waste Management:
 - .1 Submit project Waste Management Plan, and Waste Reduction Workplan highlighting recycling and salvage requirements.
 - .2 Submit calculations on end-of-project recycling rates, salvage rates, and landfill rates.
 - .3 Recycled Content:
 - .1 Submit listing of recycled content products used, including details of required percentages or recycled content materials and products, showing their costs and percentages of post-consumer and post-industrial content, and total cost of materials for project.
 - .2 Submit evidence, when Supplementary Cementing Materials (SCMs) are used, to certify reduction in cement from Base Mix to Actual SCMs Mix, as percentage.

Part 2 Products

2.1 MATERIALS

- .1 Performance graded asphalt cement: to AASHTO M320, grade PG 58 - 28 when tested to AASHTO R29.
- .2 Aggregates: in accordance with Section 31 05 16 - Aggregate Materials: General and requirements as follows:
 - .1 Crushed stone or gravel.
 - .2 Gradations: within limits specified when tested to ASTM C 136 and ASTM C 117. Sieve sizes to CAN/CGSB-8.2.
 - .3 Table:

Sieve Designation (mm)	% Passing		
	Lower Course	Surface Course	Sheet Asphalt
190	100	100	-
115	84-95	84-95	-
95	73-90	73-90	
4.75	50-75	50-75	-
2.36	35-57	35-57	-
1.18	26-45	26-45	

.60	18-34	18-34	
.30	10-26	10-26	
.15	6-17	6-17	
.075	3-7	3-7	

2.2 EQUIPMENT

- .1 Pavers: mechanical grade controlled self-powered pavers capable of spreading mix within specified tolerances, true to line, grade and crown indicated.
- .2 Rollers: sufficient number of type and weight to obtain specified density of compacted
- .3 Vibratory rollers:
 - .1 Drum diameter: 1200 mm minimum.
 - .2 Amplitude of vibration (machine setting): 0.5 mm maximum for lifts less than 40 mm thick.
- .4 Haultrucks: sufficient number and of adequate size, speed and condition to ensure orderly and continuous operation and as follows:
 - .1 Boxes with tight metal bottoms.
 - .2 Covers of sufficient size and weight to completely cover and protect asphalt mix when truck fully loaded.
 - .3 In cool weather or for long hauls, insulate entire contact area of each truck box.
 - .4 Use only trucks which can be weighed in single operation on scales supplied.
 - .5 Hand tools:
 - .1 Lutes or rakes with covered teeth for spreading and finishing operations.
 - .2 Tamping irons having mass 12 kg minimum and bearing area not exceeding 310 cm² for compacting material along curbs, gutters and other structures inaccessible to roller. Mechanical compaction equipment, when approved by Departmental Representative, may be used instead of tamping irons.
 - .3 Straight edges, 4.5 m in length, to test finished surface.
 - .6 Plant testing facility: provide laboratory space at plant site for exclusive use of Departmental Representative, for performing tests, keeping records and making reports.

2.3 MIX DESIGN

- .1 Mix design to be prepared by Contractor and approved in writing by Departmental Representative.
- .2 Mix to contain maximum 50% by mass of RAP. Departmental Representative may approve higher proportion of RAP if Contractor demonstrates ability to produce mix meeting requirements of specification.
- .3 Design of mix: by Marshall method to requirements below.

.1 Compaction blows on each face of test specimens: 75.

.2 Mix physical requirements:

Property	Roads
Marshall Stability at 60°C (kN min)	5.5
Flow Value (mm)	2-4
Air Voids in Mixture (%)	3-5 surface course/2-6 lower course
Voids in Mineral Aggregate (% min)	15 surface course/ 13 lower course
Index of Retained Stability % minimum	75

.3 Measure physical requirements as follows:

- .1 Marshall load and flow value: to AASHTO T245.
- .2 Compute void properties on basis of bulk specific gravity of aggregate to ASTM C127 and ASTM C 128. Make allowance for volume of asphalt absorbed into pores of aggregate.
- .3 Air voids: to ASTM D 3203.
- .4 Voids in mineral aggregates: to AI MS2.

.4 Do not change job-mix without prior approval of Departmental Representative. When change in material source proposed, new job-mix formula will be provided to be reviewed by Departmental Representative.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for asphalt paving in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 PREPARATION

- .1 Temporary Erosion and Sedimentation Control:
 - .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction, sediment and erosion control drawings, and sediment and erosion control plan, specific to site, that complies with EPA 832/R-92-005 or requirements of authorities having jurisdiction, whichever is more stringent.
 - .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
 - .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
- .2 Finished sub-base surface to be within 20 mm of elevation as indicated but not uniformly high or low.
- .3 Finished asphalt surface not to have irregularities exceeding 20 mm when checked with 4.5 m straight edge placed in any direction.
- .4 Correct irregularities which develop before completion of rolling by loosening surface mix and removing or adding material as required.
- .5 Apply prime coat and tack coat prior to paving.
- .5 Prior to laying mix, clean surfaces of loose and foreign material.

3.3 TRANSPORTATION OF MIX

- .1 Transport mix to job site in vehicles cleaned of foreign material.
- .2 Paint or spray truck beds with limewater, soap or detergent solution, or non-petroleum based commercial product, at least daily or as required.

- .1 Raise truck bed and thoroughly drain, and ensure no excess solution remains in truck bed.
- .3 Schedule delivery of material for placing in daylight, unless Departmental Representative approves artificial light for night placing.
- .4 Deposit mix from surge or storage silo to trucks in multiple drops to reduce segregation.
 - .1 Do not dribble mix into trucks.
- .5 Deliver material to paver at uniform rate and in an amount within capacity of paving and compacting equipment.
- .6 Deliver loads continuously in covered vehicles and immediately spread and compact.
 - .1 Deliver and place mixes at temperature within range as directed by Departmental Representative, but not less than 135 degrees C.

3.4 TEST STRIP

- .1 Construct and test strip to approval of Departmental Representative.
- .2 During construction of test strip, Departmental Representative will establish optimum rolling pattern by taking nuclear densimeter readings and observations to:
 - .1 Determine sequence and number of passes.
 - .2 Determine correct operating characteristics of vibratory rollers.
 - .3 Determine maximum density of asphalt mix.
 - .4 Ensure smooth surface finish.
 - .5 Establish actual density achieved by coring in order to determine if additional or other rolling equipment is required to achieve density of not less than [98] % of density obtained with Marshall specimens prepared from samples of mix being used.

3.5 PLACING

- .1 Obtain Departmental Representative's approval of base and existing surface and tack coat and prime coat prior to placing asphalt.
- .2 Place asphalt concrete to thicknesses, grades and lines as indicated on Contract Drawings and as directed by Departmental Representative.
- .3 Placing conditions:
 - .1 Place asphalt mixtures only when air temperature is 5 degrees C minimum.
 - .2 When temperature of surface on which material is to be placed falls below 10 degrees C, provide extra rollers as necessary to obtain required compaction before cooling.
 - .3 Do not place hot-mix asphalt when pools of standing water exist on surface to be paved, during rain, or when surface is damp.
- .4 Place asphalt concrete in compacted lifts of thickness as follows:

- .1 Levelling courses to thicknesses required but not exceeding 50 mm.
- .2 Lower course in 1 layer of 50 mm.
- .3 Surface course in 1 layer of maximum 50 mm.
- .5 Where possible do tapering and levelling where required in lower lifts. Overlap joints by not less than 300 mm.
- .6 Place individual strips no longer than 500 m.
- .7 On airport runways and taxiways, aprons and parking lots commence spreading at high side of pavement or at crown and span crowned centerlines with initial strip.
- .8 Spread and strike off mixture with self-propelled mechanical finisher.
 - .1 Construct longitudinal joints and edges true to line markings.
 - .1 Departmental Representative to review lines for paver to follow parallel to centerline of proposed pavement. Position and operate paver to follow established line closely.
 - .2 When using pavers in echelon, have first paver follow marks or lines, and second paver follow edge of material placed by first paver.
 - .1 Work pavers as close together as possible and in no case permit them to be more than 30 m apart.
 - .3 Maintain constant head of mix in auger chamber of paver during placing.
 - .4 If segregation occurs, immediately suspend spreading operation until cause is determined and corrected.
 - .5 Correct irregularities in alignment left by paver by trimming directly behind machine.
 - .6 Correct irregularities in surface of pavement course directly behind paver.
 - .1 Remove excess material forming high spots using shovel or lute.
 - .1 Fill and smooth indented areas with hot mix.
 - .2 Do not broadcast material over such areas.
 - .7 Do not throw surplus material on freshly screeded surfaces.
- .9 When hand spreading is used:
 - .1 Use approved wood or steel forms, rigidly supported to assure correct grade and cross section.
 - .1 Use measuring blocks and intermediate strips to aid in obtaining required cross-section.
 - .2 Distribute material uniformly without broadcast material.
 - .3 During spreading operation, thoroughly loosen and uniformly distribute material by lutes or covered rakes.
 - .1 Reject material that has formed into lumps and does not break down readily.

- .4 After placing and before rolling, check surface with templates and straightedges and correct irregularities.
- .5 Provide heating equipment to keep hand tools free from asphalt.
 - .1 Control temperature to avoid burning material.
 - .2 Do not use tools at higher temperature than temperature of mix being placed.

3.6 COMPACTING

- .1 Roll asphalt continuously using established rolling pattern for test strip and to density of not less than 100% of maximum density determined for test strip.
- .2 Do not change rolling pattern unless mix changes or lift thickness changes.
 - .1 Change rolling pattern only as directed by Departmental Representative.
- .3 Roll asphalt continuously to density not less than 98 % of 75 blow Marshall density to AASHTO T245.
- .4 General:
 - .1 Provide at least 2 rollers and as many additional rollers as necessary to achieve specified pavement density. When more than 2 rollers are required, 1 roller must be pneumatic tired type.
 - .2 Start rolling operations as soon as placed mix can bear weight of roller without excess displacement of material or cracking of surface.
 - .3 Operate roller slowly initially to avoid displacement of material. Do not exceed 5 km/h for breakdown and intermediate rolling for static steel-wheeled and pneumatic tired rollers. Do not exceed 9 km/h for finish rolling.
 - .4 Use static compaction for levelling coarse less than 25 mm thick.
 - .5 For lifts 50 mm thick and greater, adjust speed and vibration frequency of vibratory rollers to produce minimum of [25] impacts per metre of travel. For lifts less than 50 mm thick, impact spacing not to exceed compacted lift thickness.
 - .6 Overlap successive passes of roller by minimum of [200] mm and vary pass lengths.
 - .7 Keep wheels of roller slightly moistened with water to prevent pick-up of material but do not over-water.
 - .8 Do not stop vibratory rollers on pavement that is being compacted with vibratory mechanism operating.
 - .9 Do not permit heavy equipment or rollers to stand on finished surface before it has been compacted and has thoroughly cooled.
 - .10 After traverse and longitudinal joints and outside edge have been compacted, start rolling longitudinally at low side and progress to high side.
 - .1 Ensure that all points across width of pavement receive essentially equal numbers of passes of compactors.

- .11 When paving in echelon, leave unrolled 50 to 75 mm of edge which second paver is following and roll when joint between lanes is rolled.
- .12 Where rolling causes displacement of material, loosen affected areas at once with lutes or shovels and restore to original grade of loose material before re-rolling.
- .5 Breakdown rolling:
 - .1 Begin breakdown rolling with vibratory roller immediately following rolling of transverse and longitudinal joint and edges.
 - .2 Operate rollers as close to paver as necessary to obtain adequate density without causing undue displacement.
 - .3 Operate breakdown roller with drive roll or wheel nearest finishing machine. When working on steep slopes or super-elevated sections use operation approved by Departmental Representative.
 - .4 Use only experienced roller operators.
- .6 Intermediate rolling:
 - .1 Use pneumatic-tired, steel wheel or vibratory rollers and follow breakdown rolling as closely as possible and while paving mix temperature allows maximum density from this operation.
 - .2 Rolling to be continuous after initial rolling until mix placed has been thoroughly compacted.
- .7 Finish rolling:
 - .1 Accomplish finish rolling with two-axle or three-axle tandem steel wheeled rollers while material is still warm enough for removal of roller marks.
 - .1 If necessary to obtain desired surface finish, use pneumatic-tired rollers as directed by Departmental Representative.
 - .2 Conduct rolling operations in close sequence.
- .8 Dust entire area of sheet asphalt pavements with hydrated lime immediately after rolling to eliminate tendency to pick-up under traffic.

3.7 JOINTS

- .1 General:
 - .1 Remove surplus material from surface of previously laid strip.
 - .1 Do not deposit on surface of freshly laid strip.
 - .2 Construct joints between asphalt concrete pavement and Portland cement concrete pavement as indicated.
 - .3 Paint contact surfaces of existing structures such as manholes, curbs or gutters with bituminous material prior to placing adjacent pavement.
- .2 Transverse joints:

- .1 Offset transverse joint in succeeding lifts by at least 600 mm.
- .2 Cut back to full depth vertical face and tack face with thin coat of hot asphalt prior to continuing paving.
- .3 Compact transverse joints to provide smooth riding surface. Use methods to prevent rounding of compacted surface at joints.
- .3 Longitudinal joints:
 - .1 Offset longitudinal joints in succeeding lifts by at least 150 mm.
 - .2 Cold joint is defined as joint where asphalt mix is placed, compacted and left to cool below 100 degrees C prior to paving of adjacent lane.
 - .1 If cold joint cannot be avoided, cut back by saw cutting previously laid lane, by at least 150 mm, to full depth vertical face, and tack face with thin coat of hot asphalt of adjacent lane.
 - .3 Overlap previously laid strip with spreader by 25 to 50 mm.
 - .4 Before rolling, carefully remove and discard coarse aggregate in material overlapping joint with lute or rake.
 - .5 Roll longitudinal joints directly behind paving operation.
 - .6 When rolling with static or vibratory rollers, have most of drum width ride on newly placed lane with remaining 150 mm extending onto previously placed and compacted lane.
- .4 Construct feather joints so that thinner portion of joint contains fine graded material obtained by changed mix design or by raking out coarse aggregate in mix.
 - .1 Place and compact joint to ensure joint is smooth and without visible breaks in grade.
 - .2 Locate feather joints as indicated.
- .5 Construct butt joints as indicated.

3.8 FINISH TOLERANCES

- .1 Finished asphalt surface to be within 5 mm of design elevation but not uniformly high or low.
- .2 Finished asphalt surface not to have irregularities exceeding 5 mm when checked with 4.5 m straight edge placed in any direction.
- .3 Finished asphalt surface must be free draining such that no areas of standing water are created.
- .4 If the variance for grade is rejected by the Departmental Representative, the Contractor shall remove the lot to a depth of at least the thickness of the course involved and replace it with hot-mix asphalt meeting the Contract requirements — all at the Contractor's cost. Skin patching for correcting low areas will not be permitted. The Contractor shall bear the cost of the evaluation by the Departmental Representative

3.9 DEFECTIVE WORK

- .1 Correct irregularities which develop before completion of rolling by loosening surface mix and removing or adding material as required.
 - .1 If irregularities or defects remain after final compaction, remove surface course promptly and lay new material to form true and even surface and compact immediately to specified density.
- .2 Repair areas showing checking, rippling, or segregation.
- .3 Adjust roller operation and screed settings on paver to prevent further defects such as rippling and checking of pavement.

3.10 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 31 05 16 - Aggregate Materials
- .2 Section 01 33 00 - Submittal Procedures

1.2 MEASUREMENT AND PAYMENT

- .1 Measure granular sub-base in cubic metres of material incorporated into Work and accepted by Departmental Representative.
- .2 Measure granular base in cubic metres of material incorporated into Work and accepted by Departmental Representative.
- .3 Measure granular topping in cubic metres of material incorporated into Work and accepted by Departmental Representative.

1.3 REFERENCES

- .1 ASTM International
 - .1 ASTM C136-06, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .2 ASTM C117-04, Standard Test Method for Material Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.
 - .3 ASTM D4318-05, Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
 - .4 ASTM D698-07e1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort 12,400 ft-lbf/ft³ (600 kN-m/m³).
- .2 Canada Green Building Council (CaGBC)
 - .1 LEED Canada-NC Version 1.0-2004, LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package For New Construction and Major Renovations including Addendum 2007.
 - .2 LEED Canada-CI Version 1.0-2007, LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Guide For Commercial Interiors.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.1-[88], Sieves, Testing, Woven Wire, Inch Series.
 - .2 CAN/CGSB-8.2-[M88], Sieves, Testing, Woven Wire, Metric.

1.4 ADMINISTRATIVE REQUIREMENTS

- .1 Access: allow access to building at all times.
- .2 Scheduling: co-ordinate paving schedule to minimize interference with normal use of premises.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Store crushed stone as and where directed by Departmental Representative.

Part 2 Products

2.1 MATERIALS

- .1 Granular sub-base: in accordance with Section 31 05 16 - Aggregate Materials and following requirements:
- .1 Crushed, pit run or screened stone, gravel or sand consisting of hard durable particles free from clay lumps, cementation, organic material, frozen material and other deleterious materials.
- .2 Gradations: within limits specified when tested to ASTM C136, ASTM C117. Sieve sizes to CAN/CGSB-8.1, CAN/CGSB-8.2.
- .2 Table:

Sieve Designation	% Passing
75 mm	100
4.75 mm	25-85
0.425 mm	5-30
0.075 mm	0-10

- .3 Granular base: in accordance with Section 31 05 16 - Aggregate Materials and following requirements:
- .1 Crushed stone or gravel: hard, durable, angular particles, free from clay lumps, cementation, organic material, frozen material and other deleterious materials.
- .2 Gradations: within limits specified when tested to ASTM C136, ASTM C117. Sieve sizes to CAN/CGSB-8.1, CAN/CGSB-8.2.
- .3 Table:

Sieve Designation	% Passing
19 mm	100
12.5 mm	70-100
4.75 mm	40-70
2.00 mm	23-50
0.425 mm	7-25
0.075 mm	3-8

- .4 Liquid limit: ASTM D4318 maximum 25.
- .5 Plasticity index: ASTM D4318 maximum 6.
- .4 Granular topping:

- .1 Screenings: hard, durable, locally available (to be reviewed with departmental representative), crushed stone particles, free from clay lumps, cementation, organic material, frozen material and other deleterious materials.
- .2 Gradations: within limits specified when tested to ASTM C136, ASTM C117

Sieve Designation	% Passing
9.5 mm	100
4.75 mm	50-100
2.00 mm	30-65
0.425 mm	10-30
0.075 mm	5-10

- .5 Edging: 4.8mm x 152.4mm commercial grade aluminum edger.
- .6 Geotextile filter: Weed preventative commercial grade geo-textile fabric.

Part 3 Execution

3.1 SUBGRADE

- .1 Ensure subgrade preparation conforms to levels and compaction required, to allow for installation of granular base.

3.2 GEOTEXTILE FILTER

- .1 Install geotextile filter as indicated.

3.3 GRANULAR SUB-BASE

- .1 Granular sub-base material minimum thickness: 150 mm.
- .2 Place material in uniform layers not to exceed 150 mm compacted thickness.
 - .1 Compact layer to 100 % Standard Density in accordance with ASTM D698.

3.4 GRANULAR BASE

- .1 Granular base material thickness: 150 mm minimum.
- .2 Spread and compact granular base material in uniform layers not exceeding 100 mm compacted thickness.
- .3 Compact to a density of not less than 100 % Standard Density in accordance with ASTM D698.

3.5 EDGING

- .1 Install edging true to grade, in location and layout as indicated.

3.6 GRANULAR TOPPING

- .1 Place granular topping to compacted thickness 110 mm minimum.
- .2 Place material in uniform layers not to exceed 50 mm compacted thickness.

- .1 Compact layer to 100 % Standard Density in accordance with ASTM D698.

3.7 FIELD QUALITY CONTROL

- .1 Inspection and testing of crushed stone paving: carried out by designated testing laboratory.
- .2 Costs of tests: paid as per contract agreement between the contractor and PARKS CANADA.

3.8 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse, recycling in accordance with PARKS CANADA requirements.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.9 PROTECTION

- .1 Prevent damage to buildings, landscaping, curbs, sidewalks, trees, roads and adjacent property.
 - .1 Repair damages incurred.
- .2 Provide access to building at all times. Co-ordinate paving schedule to minimize interference with normal use of premises.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Exterior Site Furnishings

1.2 RELATED SECTIONS

- .1 -

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for furniture and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit maintenance data for care and cleaning of site furnishings.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect furnishings from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

- .1 As listed on landscape drawings.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for exterior site furnishing installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.

- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 PREPARATION

- .1 Locate and protect utility lines.
- .2 Notify and acquire written acknowledgment from utility authorities before beginning installation Work

3.3 INSTALLATION

- .1 Assemble furnishings in accordance with manufacturer's written recommendations.
- .2 Install furnishing as directed by Departmental Representative.
- .3 Touch-up damaged finishes to approval of Departmental Representative.

3.4 CLEANING

- .1 Progress Cleaning:
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

3.5 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by site furnishings installation.

END OF SECTION 32 37 00

Part 1 General

1.1 SECTION INCLUDES

- .1 topsoil materials

1.2 RELATED SECTIONS

- .1 Section 32 93 10 Trees, Shrubs and Ground Cover Planting
- .2 Section 32 92 19.16 Hydraulic seeding

1.3 DEFINITIONS

- .1 Compost:
 - .1 Mixture of soil and decomposing organic matter used as fertilizer, mulch, or soil conditioner.
 - .2 Compost is processed organic matter containing 40% or more organic matter as determined by Walkley-Black or Loss On Ignition (LOI) test.
 - .3 Product must be sufficiently decomposed (i.e. stable) so that any further decomposition does not adversely affect plant growth (C:N ratio below (25) (50)), and contain no toxic or growth inhibiting contaminants.
 - .4 Composed bio-solids to: CCME Guidelines for Compost Quality, Category (A) (B).

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Quality control submittals :
 - .1 Soil testing: submit certified test reports showing compliance with specified performance characteristics and physical properties as described in PART 2 - PRODUCTS.
OR
 - .2 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements as described in PART 2 - PRODUCTS.
 - .3 If tests indicate materials do not meet specified requirements, change material and retest.
 - .4 Provide materials of each type from same source throughout the Work.

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse or recycling in accordance with the PARKS CANADA - Construction/Demolition Waste Management and Disposal standard practices.
- .2 Divert unused soil amendments from landfill to official hazardous material collections site approved by PARKS CANADA.
- .3 Do not dispose of unused soil amendments into sewer systems, into lakes, streams, onto ground or in locations where it will pose health or environmental hazard.

Part 2 Products

2.1 TOPSOIL

- .1 Topsoil for planting beds: Fertile, agricultural soil, typical for locality i.e. PARKS CANADA APPROVED SUITABLE FOR GLACIER NATIONAL PARK APPLICATION, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, impurities, plants, weeds and roots.
 - .1 Soil texture based on The Canadian System of Soil Classification, to consist of 20 to 70 % sand, minimum 7 % clay, and contain 2 to 10 % organic matter by weight.
 - .2 Contain no toxic elements or growth inhibiting materials.
 - .3 Finished surface free from:
 - .1 Debris and stones over 50 mm diameter.
 - .2 Course vegetative material, 10 mm diameter and 100 mm length, occupying more than 2% of soil volume.
 - .4 Consistence: friable when moist.

2.2 SOIL AMENDMENTS

- .1 Fertilizer:
 - .1 Fertility: major soil nutrients present in following amounts:
 - .2 Nitrogen (N): 20 to 40 micrograms of available N per gram of topsoil.
 - .3 Phosphorus (P): 40 to 50 micrograms of phosphate per gram of topsoil.
 - .4 Potassium (K): 75 to 110 micrograms of potassium per gram of topsoil.
 - .5 Calcium, magnesium, sulfur and micro-nutrients present in balanced ratios to support germination and/or establishment of intended vegetation.
 - .6 Ph value: 6.5 to 8.0.
- .2 Peatmoss:
 - .1 Derived from partially decomposed species of Sphagnum Mosses.
 - .2 Elastic and homogeneous, brown in colour.
 - .3 Free of wood and deleterious material which could prohibit growth.
 - .4 Shredded particle minimum size: 5 mm.
- .3 Sand: washed coarse silica sand, medium to course textured.
- .4 Organic matter: compost Category A, B in accordance with CCME PN1340, unprocessed organic matter, such as rotted manure, hay, straw, bark residue or sawdust, meeting the organic matter, stability and contaminant requirements.
- .5 Use composts meeting Category B requirements for land fill reclamation and large scale industrial applications.

2.3 SOURCE QUALITY CONTROL

- .1 Advise Departmental Representative of sources of topsoil to be utilized with sufficient lead time for testing.
- .2 Contractor is responsible for arranging certified test reports at its own expense and amendments to supply topsoil as specified.
- .3 Soil testing by recognized testing facility for PH, P and K, and organic matter.

- .4 Testing of topsoil will be carried out by testing laboratory approved by Departmental Representative. Contractor to provide a list of recognized testing facilities.
 - .1 Soil sampling, testing and analysis to be in accordance with PARKS CANADA standards.

Part 3 Execution

3.1 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.
- .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.2 STRIPPING OF TOPSOIL

- .1 Begin topsoil stripping of areas as directed by Departmental Representative after area has been cleared of brush, weeds, grasses and removed from site.
- .2 Strip topsoil to depths as directed by Departmental Representative.
 - .1 Avoid mixing topsoil with subsoil where textural quality will be moved outside acceptable range of intended application.
- .3 Stockpile in locations as directed by Departmental Representative.
 - .1 Stockpile height not to exceed 2 m.
- .4 Disposal of unused topsoil is to be in an environmentally responsible manner but not used as landfill.
- .5 Protect stockpiles from contamination and compaction.
- .6 Stockpile in sufficient quantities to meet Project schedule and requirements.
- .7 Separate differing materials with dividers or stockpile apart to prevent mixing.
- .8 Prevent intermixing of soil types or contamination.
- .9 Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

3.3 STOCKPILE CLEANUP

- .1 Remove stockpile, leave area in a clean and neat condition. Grade site surface to prevent free standing surface water.
- .2 Leave unused materials in a neat, compact stockpile.
- .3 If a borrow area is indicated, leave area in a clean and neat condition. Grade site surface to prevent free standing surface water.

3.4 PREPARATION OF EXISTING GRADE

- .1 Verify that grades are correct.

- .1 If discrepancies occur, notify Departmental Representative and do not commence work until instructed by Departmental Representative.
- .2 Grade soil, eliminating uneven areas and low spots, ensuring positive drainage.
- .3 Remove debris, roots, branches, stones in excess of 50 mm diameter and other deleterious materials.
 - .1 Remove soil contaminated with calcium chloride, toxic materials and petroleum products.
 - .2 Remove debris which protrudes more than 75 mm above surface.
 - .3 Dispose of removed material off site.
- .4 Cultivate entire area which is to receive topsoil to minimum depth of 100 mm.
 - .1 Cross cultivate those areas where equipment used for hauling and spreading has compacted soil.

3.5 PLACING AND SPREADING OF TOPSOIL/PLANTING SOIL

- .1 Place topsoil after Departmental Representative has accepted subgrade.
- .2 Spread topsoil in uniform layers not exceeding 150 mm.
- .3 For seeded areas ensure that finish grade meets flush and smooth with adjacent grades and surface structures such as curbs, manholes, sidewalks, irrigation boxes etc.
- .4 For shrub, trees, perennial planting areas keep topsoil 75 mm below finished grade.
- .5 Spread topsoil to minimum depths after settlement as indicated on landscape drawings.
- .6 Manually spread topsoil/planting soil around trees, shrubs and obstacles.

3.6 FINISH GRADING

- .1 Grade to eliminate rough spots and low areas and ensure positive drainage.
 - .1 Prepare loose friable bed by means of cultivation and subsequent raking.
- .2 Consolidate topsoil to required bulk density using equipment approved by Departmental Representative.
 - .1 Leave surfaces smooth, uniform and firm against deep foot printing.

3.7 ACCEPTANCE

- .1 Departmental Representative will inspect soil testing reports submitted, as well as will review the material, depth of topsoil and finish grading on site.

3.8 SURPLUS MATERIAL

- .1 Dispose of materials except topsoil not required off site.

3.9 CLEANING

- .1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION 32 91 19.13

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 32 91 19.13 Topsoil Placement and Grading

1.2 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for seed, mulch, tackifier.
- .2 Submit in writing to Departmental Representative seven (7) days prior to commencing work:
 - .1 Volume capacity of hydraulic seeder in litres.
 - .2 Amount of material to be used per tank based on volume.
 - .3 Number of tank loads required per hectare to apply specified slurry mixture per hectare.

1.3 QUALITY ASSURANCE

- .1 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .3 Pre-Installation Meetings: conduct pre-installation meeting to verify project requirements, and installation instructions.

1.4 SCHEDULING

- .1 Schedule hydraulic seeding to coincide between dates recommended by the Departmental Representative.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Storage and Handling Requirements:
 - .1 Replace defective or damaged materials with new.

Part 2 Products

2.1 MATERIALS

- .1 Seed: "Canada pedigreed grade" in accordance with Government of Canada Seeds Act and Regulations.

- .1 Grass mixture:
 - Elymus trachycaulus* / Slender wheatgrass (25%)
 - Deschampsia caespitosa* / Tufted hairgrass (15%)
 - Poa alpine* / Alpine Bluegrass (13%)
 - Elymus glaucus* / Blue Wild Rye (25%)
 - Festuca saximontana* / Rocky Mountain fescue (22%)
- .2 Mulch: specially manufactured for use in hydraulic seeding equipment, non-toxic, water activated, green colouring, free of germination and growth inhibiting factors with following properties:
 - .1 Type I mulch:
 - .1 Made from wood cellulose fibre.
 - .2 Organic matter content: 95% plus or minus 0.5%.
 - .3 Value of pH: 6.0.
 - .4 Potential water absorption: 900%.
- .3 Tackifier: water dilutable, liquid dispersion, water soluble vegetable carbohydrate powder.
- .4 Water: free of impurities that would inhibit germination and growth.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrate previously installed under other Sections or Contracts are acceptable for hydraulic seeding in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 PROTECTION OF EXISTING CONDITIONS

- .1 Protect structures, signs, guide rails, fences, plant material, utilities and other surfaces not intended for spray.
- .2 Immediately remove any material sprayed where not intended as directed by Departmental Representative.

3.3 PREPARATION OF SURFACES

- .1 Do not perform work under adverse field conditions such as wind speeds over 10 km/h, frozen ground or ground covered with snow, ice or standing water.
- .2 Fine grade areas to be seeded free of humps and hollows.

- .1 Ensure areas are free of deleterious and refuse materials.
- .3 Cultivated areas identified as requiring cultivation to depth of 25 mm.
- .4 Ensure areas to be seeded are moist to depth of 150 mm before seeding.
- .5 Obtain Departmental Representative's approval of grade before starting to seed.

3.4 PREPARATION OF SLURRY

- .1 Measure quantities of materials by weight or weight-calibrated volume measurement satisfactory to Departmental Representative. Supply equipment required for this work.
- .2 Charge required water into seeder. Add material into hydraulic seeder under agitation. Pulverize mulch and charge slowly into seeder.
- .3 After materials are in seeder and well mixed, charge tackifier into seeder and mix thoroughly to complete slurry.

3.5 SLURRY APPLICATION

- .1 Hydraulic seeding equipment:
 - .1 Slurry tank.
 - .2 Agitation system for slurry to be capable of operating during charging of tank and during seeding, consisting of recirculation of slurry and or mechanical agitation method.
 - .3 Pumps capable of maintaining continuous non-fluctuating flow of solution.
 - .4 Supplied with not less than 6 spray pattern nozzles.
 - .5 Capable of seeding by 50 m hand operated hoses and appropriate nozzles.
 - .6 Tank volume to be certified by certifying authority and identified by authorities "Volume Certification Plate".
- .2 Slurry mixture applied per hectare.
 - .1 Seed: grass mixture 25 kg.
 - .2 Mulch: Type I 1250 kg.
 - .3 Tackifier: 20 kg.
 - .4 Water: Minimum 30,000 L.
- .3 Apply slurry uniformly, at optimum angle of application for adherence to surfaces and germination of seed.
 - .1 Using correct nozzle for application.
 - .2 Using hoses for surfaces difficult to reach and to control application.
- .4 Blend application 300 mm into adjacent grass areas, previous applications to form uniform surfaces.
- .5 Re-apply where application is not uniform.
- .6 Remove slurry from items and areas not designated to be sprayed.

3.6 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
 - .2 Keep pavement and area adjacent to site clean and free from mud, dirt, and debris at all times.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
 - .1 Clean and reinstate areas affected by Work.

3.7 PROTECTION

- .1 Protect seeded areas from trespass until plants are established.
- .2 Remove protection devices as directed by Departmental Representative.

3.8 ACCEPTANCE

- .1 Seeded areas will be accepted by Departmental Representative provided that:
 - .1 Hydro seeding work completed is compliant with the requirements outlined in Part 1 to Part 3 of this section.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Sodding

1.2 RELATED SECTIONS

- .1 Section 32 91 19.13 Topsoil placement and grading

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Scheduling:
 - .1 Schedule sod laying to coincide with preparation of soil surface.
 - .2 Schedule sod installation when frost is not present in ground.
 - .3 Pre-Installation Meetings: conduct pre-installation meeting to verify project requirements, installation instructions and warranty requirements.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for sod and fertilizer and include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Samples.
 - .1 Submit:
 - .1 Sod for each type specified.
 - .1 Install approved samples in 1 square metre mock-ups and maintain in accordance with maintenance requirements during establishment period.
 - .2 Obtain approval of samples by Departmental Representative.
- .3 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements of seed mix, seed purity, and sod quality.

1.5 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Landscape Contractor: to be a Member in Good Standing of Horticultural Trades Association.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in accordance with supplier's recommendations.

- .2 Replace defective or damaged materials with new.

Part 2 Products

2.1 MATERIALS

- .1 Number One Turf Grass Nursery Sod: sod that has been especially sown and cultivated in nursery fields as turf grass crop.
 - .1 Turf Grass Nursery Sod types:
 - .1 Number One Kentucky Bluegrass Sod - Fescue Sod: Nursery Sod grown solely from seed mixture of cultivars of Kentucky Bluegrass and Chewing Fescue or Creeping Red Fescue, containing not less than 40% Kentucky Bluegrass cultivars and 30% Chewing Fescue or Creeping Red Fescue cultivars.
 - .2 Turf Grass Nursery Sod quality:
 - .1 Not more than 1 broadleaf weed and up to 1% native grasses per 40 square metres.
 - .2 Density of sod sufficient so that no soil is visible from height of 1500 mm when mown to height of 50 mm.
 - .3 Mowing height limit: 35 to 65 mm.
 - .4 Soil portion of sod: 6 to 15 mm in thickness.
 - .2 Sod establishment support:
 - .1 Wooden pegs: [17 x 8 x 200] mm.
Biodegradable starch pegs: [17 x 8 x 200] mm.
 - .3 Water:
 - .1 Supplied by the contractor at designated source.
 - .4 Fertilizer:
 - .1 To Canada "Fertilizers Act" and Fertilizers Regulations.
 - .2 Complete, synthetic, slow release with 65 % of nitrogen content in water-insoluble form.

2.2 SOURCE QUALITY CONTROL

- .1 Obtain written approval from Departmental Representative of sod at source.
- .2 When proposed source of sod is approved, use no other source without written authorization from Departmental Representative.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for sod installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.

- .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of approval to proceed from Departmental Representative.

3.2 PREPARATION

- .1 Verify that grades are correct and prepared in accordance with Section 32 91 19.13 - Topsoil Placement and Grading. If discrepancies occur, notify Departmental Representative and commence work when instructed by Departmental Representative.
- .2 Do not perform work under adverse field conditions such as frozen soil, excessively wet soil or soil covered with snow, ice, or standing water.
- .3 Fine grade surface free of humps and hollows to smooth, even grade, to contours and elevations indicated, to tolerance of plus or minus 8 mm, for Turf Grass Nursery Sod, surface to drain naturally.
- .4 Remove and dispose of weeds; debris; stones 50 mm in diameter and larger; soil contaminated by oil, gasoline and other deleterious materials; off site, in accordance with Parks Canada - Construction/Demolition Waste Management and Disposal standard practices.

3.3 SOD PLACEMENT

- .1 Ensure sod placement is done under supervision of certified Landscape Planting Supervisor.
- .2 Lay sod within 24 hours of being lifted if air temperature exceeds 20 degrees C.
- .3 Lay sod sections in rows, joints staggered. Butt sections closely without overlapping or leaving gaps between sections. Cut out irregular or thin sections with sharp implements.
- .4 Roll sod as directed by Departmental Representative. Provide close contact between sod and soil by light rolling. Use of heavy roller to correct irregularities in grade is not permitted.

3.4 SOD PLACEMENT ON SLOPES AND PEGGING

- .1 Install and secure geotextile fabric in areas indicated, in accordance with manufacturer's instructions.
- .2 Start laying sod at bottom of slopes.
- .3 Peg sod on slopes steeper than 3 horizontal to 1 vertical, within 1 m of catch basins and within 1 m of drainage channels and ditches to following pattern:
 - .1 100 mm below top edge at 200 mm on centre for first sod sections along contours of slopes.
 - .2 Not less than 3-6 pegs per square metre.
 - .3 Not less than 6-9 pegs per square metre in drainage structures. Adjust pattern as directed by Departmental Representative.

Drive pegs to 20 mm above soil surface of sod sections.

3.5 FERTILIZING PROGRAM

- .1 Fertilize during establishment and warranty periods.

3.6 CLEANING

- .1 Progress Cleaning:
 - .1 Leave Work area clean at end of each day.
 - .2 Keep pavement and area adjacent to site clean and free from mud, dirt, and debris at all times.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.
 - .1 Clean and reinstate areas affected by Work.

3.7 PROTECTION BARRIERS

- .1 Protect newly sodded areas from deterioration with snow fence on rigid frame as directed by Departmental Representative.
 - Remove protection after inspection as directed by Departmental Representative.

3.8 MAINTENANCE DURING ESTABLISHMENT PERIOD

- .1 Perform following operations from time of installation until acceptance.
 - .1 Water sodded areas in sufficient quantities and at frequency required to maintain optimum soil moisture condition to depth of 75 to 100 mm.
 - .2 Cut grass to 50 mm when or prior to it reaching height of 75 mm.
 - .3 Maintain sodded areas weed free 95%.
 - .4 Fertilize areas in accordance with fertilizing program. Spread half of required amount of fertilizer in one direction and remainder at right angles and water in well.
 - .5 Temporary barriers or signage to be maintained to protect newly established sod.

3.9 ACCEPTANCE

- .1 Turf Grass Nursery Sod areas will be accepted by Departmental Representative provided that:
 - .1 Sodded areas are properly established.
 - .2 Sod is free of bare and dead spots.
 - .3 No surface soil is visible from height of 1500 mm when grass has been cut to height of 50 mm.
 - .4 Sodded areas have been cut minimum 2 times prior to acceptance.
- .2 Areas sodded in fall will be accepted in following spring one month after start of growing season provided acceptance conditions are fulfilled.
- .3 When environmental conditions allow, all sodded areas showing shrinkage cracks shall be top-dressed and seeded with a seed mix matching the original.
- .4 Areas sodded in fall will be accepted in following spring one month after start of growing season provided acceptance conditions are fulfilled.

3.10 MAINTENANCE DURING WARRANTY PERIOD

- .1 Perform following operations from time of acceptance until end of warranty period:
 - .1 Water sodded areas at weekly intervals to obtain optimum soil moisture conditions to depth of 100 mm.

- .2 Repair and re-sod dead or bare spots to satisfaction of Departmental Representative.
- .3 Cut grass and remove clippings as directed by Departmental Representative to height as follows:
 - .1 Turf Grass Nursery Sod:
 - .1 50 mm during normal growing conditions.
 - .2 Cut grass at 2 week intervals or as directed by Departmental Representative, but at intervals so that approximately one third of growth is removed in single cut.
 - .3 Fertilize areas in accordance with fertilizing program. Spread half of required amount of fertilizer in one direction and remainder at right angles and water in well.
 - .4 Eliminate weeds by mechanical or chemical means, to extent acceptable to Departmental Representative.

END OF SECTION 32 92 23

Part 1 General

1.1 SECTION INCLUDES

- .1 Preparation of subsoil.
- .2 Topsoil bedding.
- .3 Plants - Trees, Shrubs, Perennials, Ground cover.
- .4 Mulch.
- .5 Maintenance.
- .6 Tree Pruning.

1.2 RELATED SECTIONS

- .1 Section 32 91 19.13 Topsoil Placement and Grading

1.3 PRICE AND PAYMENT PROCEDURES

- .1 Unit Prices:
 - .1 Topsoil: By the cubic metre. Includes preparation of subsoil, preparation of topsoil, placing topsoil.
 - .2 Plants: By the unit – purchase, delivery and installation. Includes planting, watering and maintenance to specified time period.

1.4 DEFINITIONS

- .1 Weeds: Include Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass. ADDITIONAL PLANTS AS COVERED UNDER PARKS CANADA LIST OF PLANTS CLASSIFIED AS WEEDS FOR THE GLACIER NATIONAL PARK AREA.
- .2 Weeds: Any plant life not specified or scheduled.
- .3 Plants: Living trees, shrubs, perennials and ground cover specified in this Section and described in ANLA Z60.1.

1.5 ADMINISTRATIVE REQUIREMENTS

- .1 Coordination:
 - .1 Coordinate with other work having a direct bearing on work of this section.

1.6 SUBMITTALS FOR INFORMATION

- .1 Advise Departmental Representative of the selected Nursery (plant supplier) and tag all scheduled plants at the Nursery for Departmental Representative's review and approval with sufficient lead time prior to scheduling delivery of plants on site.

1.7 CLOSEOUT SUBMITTALS

- .1 Maintenance Contracts:
 - .1 Maintain plant life immediately after placement until plants are well established and exhibit a vigorous growing condition. Continue maintenance until termination of warranty period.
- .2 Maintenance to include:
 - .1 Cultivation and weeding plant beds and tree pits.
 - .2 Applying herbicides for weed control in accordance with manufacturer's written instructions. Remedy damage resulting from use of herbicides. Any use of herbicides and insecticides is to conform to Parks Canada requirements regarding permissibility of use and if permitted, conformance to Parks Canada requirements for safe application of chemicals and disposal of waste products.
 - .3 Remedy damage from use of insecticides.
 - .4 Irrigating (water truck) sufficient to saturate root system.
 - .5 Pruning, including removal of dead or broken branches, and treatment of pruned areas or other wounds.
 - .6 Disease control.
 - .7 Maintaining wrapping, guys, turnbuckles and stakes. Adjust turnbuckles to keep guy wires tight. Repair or replace accessories when required.
 - .8 Replacement of mulch.
- .3 Maintenance Data: Include cutting and trimming method; types, application frequency, and recommended coverage of fertilizer.
- .4 Plant Source: Submit list of plant life sources.

1.8 QUALITY ASSURANCE

- .1 Nursery Qualifications: Company specializing in growing and cultivating the plants..
- .2 Installer Qualifications: Company specializing in installing and planting the plants..
- .3 Tree Pruner Qualifications: Company specializing in pruning trees with proof of Arborist Certification.

REGULATORY REQUIREMENTS

Comply with regulatory agencies for fertilizer composition.

- 1.9**
 - .1 Provide certificate of compliance from Canadian Nursery Trades Association indicating approval of plants, herbicide, and fertilizer mixture.
 - .2 Plant Materials: Described by ANLA Z60.1; free of disease or hazardous insects.

DELIVERY, STORAGE, AND PROTECTION

- .3 Protect and maintain plant life until planted.
- 1.10**
 - .1 Deliver plant life materials immediately prior to placement. Keep plants moist.
 - .2

1.11 ENVIRONMENTAL REQUIREMENTS

- .1 Do not install plant life when ambient temperatures may drop below 2 degrees C or rise above 32 degrees C.
- .2 Do not install plant life when wind velocity exceeds 48 k/hr.

1.12 WARRANTY

- .1 Provide one (1) year warranty.
- .2 Warranty: Include coverage for one continuous growing season; replace dead or unhealthy plants.
- .3 Replacements: Plants of same size and species as specified, planted in the next growing season, with a new warranty commencing on date of replacement.

Part 2 Products

2.1 TREES, PLANTS, AND GROUND COVER

- .1 Trees, Plants, Ground Cover: Species and size identifiable in plant schedule, grown in climatic conditions similar to those in Town of Banff.

2.2 SOIL MATERIALS

- .1 Topsoil: As specified in Section 32 91 19.13.

2.3 MULCH MATERIALS

- .1 Mulching Material: Locally sourced fine textured Wood Chip Mulch as per Parks Canada requirement for Glacier National Park, free of growth or germination inhibiting ingredients, weeds, foreign matter detrimental to plant life, and dry.

2.4 ACCESSORIES

- .1 Wrapping Materials: Burlap.
- .2 Stakes: Mild steel angle, galvanized, pointed end.
- .3 Cable, Wire, Eye Bolts and Turnbuckles: Non-corrosive, of sufficient strength to withstand wind pressure and resulting movement of plant life.
- .4 Plant Protectors: Rubber sleeves over cable to protect plant stems, trunks, and branches.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify that prepared subsoil and planters are ready to receive work.
- .2 Saturate soil with water to test drainage.
- .3 Verify that required underground utilities are available, in proper location, and ready for use.

3.2 PREPARATION OF SUBSOIL

- .1 Prepare subsoil to eliminate uneven areas. Maintain profiles and contours. Make changes in grade gradual. Blend slopes into level areas.
- .2 Remove foreign materials, weeds and undesirable plants and their roots. Remove contaminated subsoil.
- .3 Scarify subsoil to a depth of 75 mm where plants are to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted subsoil.
- .4 Dig pits and beds 150 mm larger than plant root system.

3.3 PLACING TOPSOIL

- .1 Spread topsoil to a minimum depth of 150 mm over area to be planted. Rake smooth.
- .2 Place topsoil during dry weather and on dry unfrozen subgrade.
- .3 Remove vegetable matter and foreign non-organic material from topsoil while spreading.
- .4 Grade topsoil to eliminate rough, low or soft areas, and to ensure positive drainage.

3.4 PLANTING

- .1 Place plants for best appearance for review and final orientation by Departmental Representative.
- .2 Set plants vertical.
- .3 Remove non-biodegradable root containers.
- .4 Set plants in pits or beds, partly filled with prepared plant mix, at a minimum depth as indicated on drawings. Remove burlap, ropes, and wires, from the root ball.
- .5 Saturate soil with water when the pit or bed is half full of topsoil and again when full.

3.5 PLANT SUPPORT

- .1 If required, brace plants vertically with plant protector wrapped guy wires and stakes to the following tree caliper and support method:
 - .1 50 - 100 mm, three (3) guy wires with eye bolts and turn buckles.
 - .2 Over 100 mm, four (4) guy wires with eye bolts and turn buckles.

3.6 TREE PRUNING

- .1 Prune trees to NAA Class 2 - Medium Pruning.

3.7 FIELD QUALITY CONTROL

- .1 Plants will be rejected if a ball of earth surrounding roots has been disturbed or damaged prior to or during planting.

3.8 MAINTENANCE

- .1 Neatly trim plants where necessary.
- .2 Immediately remove clippings after trimming.
- .3 Water to prevent soil from drying out.

- .4 Control growth of weeds. Apply herbicides in accordance with manufacturer's written instructions.
- .5 Apply pesticides in accordance with manufacturers written instructions.

3.9 SCHEDULE - PLANT LIST

Refer to Landscape Drawings for plant schedule.

END OF SECTION 32 93 10

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 03 20 00 - Concrete Reinforcement.
- .2 Section 03 30 00 — Cast in place Concrete.
- .3 Section 31 00 99 — Earthworks for Minor Works.

1.2 REFERENCE STANDARDS

- .1 ASTM International
 - .1 ASTM A 48/A 48M-03(2012), Standard Specification for Grey Iron Castings.
 - .2 ASTM A 123/A 123M-2012, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - .3 ASTM C 117-13, Standard Test Method for Materials Finer than 75-mm (No, 200) Sieve in Mineral Aggregates by Washing.
 - .4 ASTM C136-06, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .5 ASTM C 139-11, Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes.
 - .6 ASTM C 478M-13, Standard Specification for Precast Reinforced Concrete Manhole Sections (Metric).
 - .7 ASTM D 698-12, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/IU (600 kN-m/mu)).
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.
- .3 CSA Group
 - .1 CSA A23.1/A23.2-09, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
 - .2 CAN/CSA-A165 Series-04(R2009), CSA Standards on Concrete Masonry Units (Consists of A165.1, A165.2 and A165.3).
 - .3 CAN/CSA-A3000-08, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).
 - .4 CSA G30.18-09, Carbon Steel Bars for Concrete Reinforcement.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for maintenance holes and catch basin structures and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings to be approved by Departmental Representative.

1.4 QUALITY ASSURANCE

- .1 Submit in accordance with Section 01 45 00 - Quality Control.
- .2 Certifications:
 - .1 Submit manufacturer's test data and certification at least 4 weeks prior to beginning Work. Include manufacturer's drawings, information and shop drawings where pertinent.
 - .2 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, and cleaning procedures.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect maintenance holes and catch basin structures from nicks, scratches, and blemishes.

1.6 SCHEDULING OF WORK

- .1 Schedule work to minimize interruptions to existing services and to maintain existing flow during construction.

Part 2 Products

2.1 MATERIALS

- .1 Cast-in-place concrete:
 - .1 In accordance with Section 03 30 00 - Cast-in-Place Concrete.
- .2 Concrete reinforcement: in accordance with Section 03 20 00 - Concrete Reinforcing.
- .3 Precast maintenance hole units: to ASTM C 478M, circular or oval.
 - .1 Top sections eccentric cone or flat slab top type with opening offset for vertical ladder installation.
 - .2 Monolithic bases to be approved by Departmental Representative.
- .4 Precast catch basin sections: to ASTM C 478M.
- .5 Joints: made watertight using rubber rings.
- .6 Mortar:
 - .1 Aggregate: to CSA A82.56.
 - .2 Masonry Cement: to CAN/CSA-A8.
- .7 Ladder rungs: to CSAG30.18, No.25M billet steel deformed bars, hot dipped galvanized to ASTM A 123/A 123M.
 - .1 Rungs to be safety pattern (drop step type).
- .8 Adjusting rings: to ASTM C 478M.
- .9 Concrete Brick: to CAN/CSA-A165 Series.
- .10 Drop maintenance hole pipe: same as sewer pipe.
- .11 Steel gratings, I-beams and fasteners: as indicated.
- .12 Frames, gratings, covers to dimensions as indicated and following requirements:
 - .1 Metal gratings and covers to bear evenly on frames.
 - .1 Frame with grating or cover to constitute one unit.
 - .2 Assemble and mark unit components before shipment.
 - .2 Gray iron castings: to ASTM A 48/A 48M, strength class 30B.
 - .3 Castings:
 - .1 Coated with two applications of asphalt varnish.
 - .2 Sand blasted or cleaned and ground to eliminate surface imperfections.
 - .4 Maintenance hole frames and covers: cover cast without perforations and complete with two 25 mm square lifting holes.
- .13 Granular bedding and backfill: in accordance with Section 31 00 99 — Earthworks for Minor Works, and following requirements:

- .1 Crushed screed stone, gravel or sand.
- .2 Gradations to be within limits specified when tested to ASTM C 136. Sieve sizes to CAN/CGSB-8.1.
- .3 Table:

Sieve Designation (mm)	% Passing	
	Stone/Gravel	Gravel/Sand
25	100	
12.5	65-90	100
4.75	35-55	50-100
2.00	-	30-90
.425	10-25	10-50
.075	0-8	0-10

- .4 Concrete mixes and materials: in accordance with Section 03 30 00 - Cast-in-Place Concrete.
- .14 Unshrinkable fill: in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

2.2 PRE-CAST VAULTS AND CHAMBERS

- .1 Manufacturer to have AASHTO recognized third party certification.
- .2 Detailed shop drawing in accordance with Section 01 33 00 — Submittal Procedures.
- .3 Concrete vault inside dimensions:
 - .1 Sediment chambers: 3.0x1.5x2.0m
 - .2 Detention chambers: 5.0x2.1x2.0m
- .4 Knock out cores to be provided as required.
- .5 Unit to come with lifting insert.
- .6 Chamber c/w 254mm thick lid w/ triple door as shown on Contract Drawings.
- .7 Each core to have additional reinforcement placed around the core equal to or greater than the steel area removed for the core.
- .8 All reinforcement has a minimum of 25mm concrete cover.
- .9 Minimum concrete strength: 35 mpa
- .10 Minimum rebar yield strength: 414 mpa

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for maintenance holes and catch basin structures installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 EXCAVATION AND BACKFILL

- .1 Excavate and backfill in accordance with Section 31 00 99 — Earthwork for Minor Works and as indicated.
- .2 Obtain approval of Departmental Representative before installing maintenance holes or catch basins.

3.3 CONCRETE WORK

- .1 Do concrete work in accordance with Section 03 30 00 - Cast-in-Place Concrete.
- .2 Place concrete reinforcement in accordance with Section 03 2000 - Concrete Reinforcing.
- .3 Position metal inserts in accordance with dimensions and details as indicated.

3.4 INSTALLATION

- .1 Construct units in accordance with details indicated, plumb and true to alignment and grade.
- .2 Complete units as pipe laying progresses.
 - .1 Maximum of 3 units behind point of pipe laying will be allowed.
- .3 Dewater excavation to approval of Departmental Representative and remove soft and foreign material before placing concrete base.
- .4 Cast bottom slabs directly on undisturbed ground.
- .5 Set precast concrete base on 150 mm minimum of granular bedding compacted to 100% corrected maximum dry density.
- .6 Precast units:
 - .1 Set bottom section of precast unit in bed of cement mortar and bond to concrete slab or base

- .2 Make each successive joint watertight with Departmental Representative's approved rubber ring gaskets, bituminous compound, cement mortar, epoxy resin cement, or combination of these materials.
- .3 Clean surplus mortar and joint compounds from interior surface of unit as work progresses.
- .4 Plug lifting holes with precast concrete plugs set in cement mortar or mastic compound.
- .7 For sewers:
 - .1 Place stub outlets and bulkheads at elevations and in positions indicated.
 - .2 Bench to provide smooth U-shaped channel.
- .8 Compact granular backfill to 95% corrected maximum dry density.
- .9 Place unshrinkable backfill in accordance with Section 31 00 99 — Earthworks for Minor Works.
- .10 Set frame and cover to required elevation on no more than 4 courses of brick.
 - .1 Make brick joints and join brick to frame with cement mortar.
 - .2 Purge and make smooth and watertight.
- .11 Place frame and cover on top section to elevation as indicated.
 - .1 If adjustment required use concrete ring.
- .12 Clean units of debris and foreign materials.
 - .1 Remove fins and sharp projections.
 - .2 Prevent debris from entering system.
- .13 Install safety platforms in maintenance holes having depth of 5 m or greater, as indicated.

3.5 FIELD QUALITY CONTROL

- .1 Leakage Test:
 - .1 Install watertight plugs or seals on inlets and outlets of each new maintenance hole and fill maintenance hole with water.
 - .2 Leakage not to exceed 0.3% per hour of volume of maintenance hole.
 - .3 If permissible leakage is exceeded, correct defects.
 - .4 Repeat until approved by Departmental Representative.
 - .5 Departmental Representative will issue Test Certificate for each maintenance hole passing test.
 - .6 Provide copy certification of leakage test acceptance to Departmental Representative. Include certification in Commissioning Manual.

3.6 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 33 00 — Submittal Procedures
- .2 Section 03 30 00 — Cast-in-Place Concrete
- .3 Section 31 00 99 — Earthwork for Minor Works
- .4 Section 32 23 22.01 — Excavation, Trenching, and Backfilling

1.2 REFERENCE STANDARDS

- .1 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .1 ANSI/AWWA B300-10, Standard for Hypochlorites.
 - .2 ANSI/AWWA B303-10, Standard for Sodium Chlorite.
 - .3 ANSI/AWWA C111/A21.11-07, American National Standard for Rubber-Gasket Joints for Ductile-Iron and Fittings.
 - .4 ANSI/AWWA C110/A21.10-08, American National Standard for Ductile-Iron and Grey Iron Fittings for Water.
 - .5 ANSI/AWWA C150/A21.50-08, Standard for Thickness Design of Ductile-Iron Pipe.
 - .6 ANSI/AWWA C151/A21.51-09, Standard for Ductile-Iron Pipe, Centrifugally Cast.
 - .7 ANSI/AWWA C153/A21.53-11, Standard for Ductile-Iron Compact Fittings.
 - .8 ANSI/AWWA C500-09, Standard for Metal-Seated Gate Valves for Water Supply Service.
 - .9 ANSI/AWWA C600-10, Standard for Installation of Ductile-Iron Water Mains, and Their Appurtenances.
 - .10 ANSI/AWWA C651-05, Standard for Disinfecting Water Mains.
 - .11 ANSI/AWWA C900-07, Standard for Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 Inch through 12 Inch (100 mm - 300 mm), for Water Transmission and Distribution.
- .2 ASTM International
 - .1 ASTM C 117-04, Standard Test Methods for Material Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.
 - .2 ASTM C 136-06, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .3 ASTM D 698-07e1, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/IU (600 kN-in/md)).
- .3 American Water Works Association (AWWA)/Manual of Practice

- .1 AWWA M11-2004, Steel Pipe - A Guide for Design and Installation.
- .2 AWWA M17-2006, Installation, Field Testing, and Maintenance of Fire Hydrants.
- .4 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.
 - .2 CGSB 41-GP-2SM-77, Pipe, Polyethylene, for the Transport of Liquids.
- .5 CSA International
- .6 The Master Painters Institute (MPI)
 - .1 Architectural Painting Specification Manual - current edition.
- .7 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S520-07, Standard for Fire Hydrants.
 - .2 CAN/ULC-5543-09, Standard for Internal-Lug, Quick Connect Couplings for Fire Hose.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for distribution piping materials and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Pipe certification to be on pipe.
- .3 Samples:
 - .1 Inform Departmental Representative of proposed source of bedding materials and provide access for sampling at least 4 weeks prior to commencing work.
 - .2 Submit manufacturer's test data and certification that pipe materials meet requirements of this section 4 weeks minimum prior to beginning work. Include manufacturer's drawings, information and shop drawings where pertinent.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Submit data to produce record drawings, including directions for operating valves, list of equipment required to operate valves, details of pipe material, location of air and vacuum release valves, hydrant details.
 - .1 Include top of pipe, horizontal location of fittings and type, valves, valve boxes, valve chambers and hydrants.
- .3 Operation and Maintenance Data: submit operation and maintenance data for pipe, valves, valve boxes, valve chambers and hydrants for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect water distribution piping from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

1.6 SCHEDULING OF WORK

- .1 Schedule Work to minimize interruptions to existing services.
- .2 Submit schedule of expected interruptions for approval and adhere to interruption schedule as approved by Departmental Representative.
- .3 Notify Departmental Representative minimum of 24 hours in advance of interruption in service.
- .4 Do not interrupt water service for more than 3 hours and confine this period between 10:00 and 16:00 hours local time unless otherwise authorized.
- .5 Notify Departmental Representative of planned or accidental interruption of water supply to hydrants.
- .6 Provide and post "Out of Service" sign on hydrant not in use.
- .7 Advise local police department of anticipated interference with movement of traffic.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Tools: provide tools as follows:
 - .1 Service post wrenches for curb stops.
 - .2 Hydrant wrenches.
 - .3 Tee-handle operating keys for valves.

Part 2 PRODUCTS

2.1 PIPE, JOINTS AND FITTINGS

- .1 Polyvinyl chloride pressure pipe: to ANSI/AWWA C900, pressure class 150, DR 18, 1 MPa gasket bell end.

- .1 CSA-B137.3, PVC series 160, 1.1 MPa elastomeric gasket and/or coupling.
- .2 Cast iron fittings: to ANSI/AWWA C110/A21.10, and for pipe diameters larger than NPS4 cement mortar lined to ANSI/AWWA C104/A21.4.

2.2 PIPE PROTECTION

- .1 Provide means of protection for iron pipe in corrosive soils in accordance with local practices and authorities having jurisdiction.

2.3 VALVES AND VALVE BOXES

- .1 Valves to open counter clockwise.
- .2 Gate valves: to AWWA C500, standard iron body, bronze mounted wedge or double disc valves with non-rising stems, suitable for 1 Pa with hub or flanged joints.
- .3 Underground type indicator valve to be installed at locations shown on contract drawings. Indicator post to accurately indicate valve open or closed.
- .4 Air and vacuum release valves: heavy duty combination air release valves employing direct acting kinetic principle.
 - .1 Fabricate valves of cast iron body and cover, with bronze trim, stainless steel floats with shock-proof synthetic seat suitable for 2070 kPa working pressure.
 - .2 Valves to expel air at high rate during filling, at low rate during operation, and to admit air while line is being drained.
 - .3 Valve complete with surge check unit.
 - .4 Ends to be flanged to ANSI/AWWA C110/A21.10.
- .5 Cast iron valve boxes: bituminous coated screw type adjustable over minimum of 450 mm complete with valve operating extension rod, 30 mm minimum diameter, 25 x 25 mm cross section, of such length that when set on valve operating nut top of rod will not be more than 150 mm below cover.
 - .1 Base to be large round type with minimum diameter of 300 mm.
 - .2 Top of box to be marked "WATER"/"EAU".

2.4 HYDRANTS

- .1 Hydrants: compression type hydrant, to CAN/ULC-5520, with two 65 mm threaded hose outlets, one 100 mm threaded pumper connection, 150 mm riser barrel, 125 mm bottom valve and 150 mm connection for main.
 - .1 Hydrants to open counter clockwise, threads to local standard. Provide metal caps and chains.
 - .2 Provide key operated gate valve located 1 m from hydrant.
- .2 Hydrant paint: exterior enamel to MPI #96.

2.5 SELF-DRAINING STANDPIPE

- .1 Diameter: 50mm
- .2 Check Valve
 - .1 Size: 50mm
 - .2 Conical Lead Free silent check valve
 - .3 PTFE seat
 - .4 Minimum Pressure rating: 400psi WOG non-shock & 15psi WSP
- .3 Reducer: 50mm x 38mm
- .4 Threaded Fire-Hose Connection: 38mm
- .5 Cast Iron to ASTM A-126-B
- .6 Mild Steel to SAE 1020
- .7 Bronze to ASTM B-62
- .8 Urethane: Durometer 60
- .9 Parts List
 - .1 Handwheel: Aluminum
 - .2 Handwheel Bolt: Brass
 - .3 Washer: Brass
 - .4 Handwheel Stem: Cast Bronze
 - .5 Top End "O" Ring: Houghton — 221
 - .6 Handwheel Stem Pin: Stainless Steel
 - .7 Top End: Cast Iron
 - .8 Pipe: Steel
 - .9 Operating Rod: Steel
 - .10 Gate Pin: Stainless Steel
 - .11 Drain Shield: Plastic
 - .12 Screwed Gate "O" Ring: Houghton — 227
 - .13 Bottom End: Cast Bronze
 - .14 Screwed Gate: Cast Bronze
 - .15 Cotter Pin: Brass
 - .16 Valve Discwasher: Steel
 - .17 Valve Disc: Urethane

PIPE BEDDING AND SURROUND MATERIAL

- 2.6 Granular material to: Section 31 00 99 —Earthwork for Minor Works and following requirements:
- .1

- .1 Crushed or screened stone, gravel or sand.
- .2 Gradations to be within limits specified when tested to ASTM C 136 and ASTM C 117. Sieve sizes to CAN/CGSB-8.2.
- .3 Table

Sieve Designation (mm)	% Passing	
	Stone/Gravel	Gravel/Sand
75		
50		
38.1		
25	100	
19		
12.5	65-90	100
9.5		
4.75	35-55	50-100
2.00		30-90
.425	10-25	10-50
.180		
.075	0-8	0-10

- .2 Concrete mixes and materials required for bedding cradles, encasement, supports, thrust blocks: to Section 03 30 00 - Cast-in-Place Concrete.

2.7 BACKFILL MATERIAL

- .1 In accordance with Section 31 00 99 — Earthwork for Minor Works.

2.8 PIPE DISINFECTION

- .1 Sodium hypochlorite, ANSI/AWWA B300 to disinfect water mains.
- .2 Disinfect water mains in accordance with ANSI/AWWA C651.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for distribution piping installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.

- .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 PREPARATION

- .1 Clean pipes, fittings, valves, hydrants, and appurtenances of accumulated debris and water before installation.
 - .1 Inspect materials for defects to approval of Departmental Representative.
 - .2 Remove defective materials from site as directed by Departmental Representative.

3.3 TRENCHING

- .1 Do trenching work in accordance with Section 33 00 99 — Earthwork for Minor Works.
- .2 Ensure trench depth allows coverage over pipe as indicated.
- .3 Trench alignment and depth require Departmental Representative's approval prior to placing bedding material and pipe.

3.4 CONCRETE BEDDING AND ENCASEMENT

- .1 Do concrete work in accordance with Section 03 30 00 - Cast-in-Place Concrete.
 - .1 Place concrete to details as directed by Departmental Representative.
- .2 Pipe may be positioned on concrete blocks to facilitate placing of concrete. When necessary, rigidly anchor or weight pipe to prevent flotation when concrete is placed.
- .3 Do not backfill over concrete within 24 hours after placing.

3.5 GRANULAR BEDDING

- .1 Place granular bedding material in uniform layers not exceeding 150 mm compacted thickness to depth as indicated.
- .2 Do not place material in frozen condition.
- .3 Shape bed true to grade to provide continuous uniform bearing surface for pipe.
- .4 Shape transverse depressions in bedding as required to suit joints.
- .5 Compact each layer full width of bed to 95% maximum density to ASTM D 698.
- .6 Fill authorized or unauthorized excavation below design elevation of bottom of specified bedding with compacted bedding material.

3.6 PIPE INSTALLATION

- .1 Lay pipes to ANSI/AWWA C600 and Manufacturer's standard instructions and specifications.

- .1 Do not use blocks except as specified.
- .2 Join pipes in accordance with ANSI/AWWA C600 and manufacturer's recommendations.
- .3 Bevel or taper ends of PVC pipe to match fittings.
- .4 Handle pipe by methods approved by Departmental Representative and recommended by pipe manufacturer. Do not use chains or cables passed through pipe bore so that weight of pipe bears on pipe ends.
- .5 Lay pipes on prepared bed, true to line and grade.
 - .1 Ensure barrel of each pipe is in contact with shaped bed throughout its full length.
 - .2 Take up and replace defective pipe.
 - .3 Correct pipe which is not in true alignment or grade or pipe which shows differential settlement after installation greater than 10 mm in 3 m.
- .6 Do not exceed permissible deflection at joints as recommended by pipe manufacturer.
- .7 Keep jointing materials and installed pipe free of dirt and water and other foreign materials.
 - .1 Whenever work is stopped, install a removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.
- .8 Position and join pipes with equipment and methods approved by Departmental Representative.
 - .9 Cut pipes in approved manner as recommended by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.
- .10 Align pipes before jointing.
- .11 Install gaskets to manufacturer's recommendations. Support pipes with hand slings or crane as required to minimize lateral pressure on gasket and maintain concentricity until gasket is properly positioned.
- .12 Avoid displacing gasket or contaminating with dirt or other foreign material.
 - .1 Remove disturbed or contaminated gaskets.
 - .2 Clean, lubricate and replace before jointing is attempted again.
- .13 Complete each joint before laying next length of pipe.
- .14 Minimize deflection after joint has been made.
- .15 Apply sufficient pressure in making joints to ensure that joint is completed to manufacturer's recommendations.
- .16 Ensure completed joints are restrained by compacting bedding material alongside and over installed pipes or as otherwise approved by Departmental Representative.
- .17 When stoppage of work occurs, block pipes in an approved manner to prevent creep during down time.

- .18 Recheck plastic pipe joints assembled above ground after placing in trench to ensure that no movement of joint has taken place.
- .19 Do not lay pipe on frozen bedding.
- .20 Do hydrostatic and leakage test and have results approved by Departmental Representative before surrounding and covering joints and fittings with granular material.
- .21 Backfill remainder of trench.

3.7 VALVE INSTALLATION

- .1 Install valves to manufacturer's recommendations at locations as indicated.
- .2 Support valves located in valve boxes or valve chambers by means of bedding same as adjacent pipe. Maximum length of pipe on each end of valve shall be 1 m. Valves not to be supported by pipe.
- .3 Install underground post-type indicator valves as indicated.

3.8 HYDRANTS

- .1 Install hydrants at locations as indicated.
- .2 Install hydrants in accordance with AWWA M17.
- .3 Install 150 mm gate valve and cast iron valve box on hydrant service leads as indicated.
- .4 Set hydrants plumb, with hose outlets parallel with edge of pavement or curb line, with pumper connection facing roadway and with body flange set at elevation of 50 mm above final grade.
- .5 Place concrete thrust blocks as indicated and specified ensuring that drain holes are unobstructed.
- .6 To provide proper draining for each hydrant, excavate pit measuring not less than 1 x 1 x 0.5 m deep and backfill with coarse gravel or crushed stone to level 150 mm above drain holes.
- .7 Place appropriate sign on installed hydrants indicating whether or not they are in service during construction.

3.9 THRUST BLOCKS AND RESTRAINED JOINTS

- .1 For thrust blocks: do concrete Work in accordance with Section 03 30 00 - Cast-in-Place Concrete.
- .2 Place concrete thrust blocks between valves, tees, plugs, caps, bends, changes in pipe diameter, reducers, hydrants and fittings and undisturbed ground as indicated or as directed by Departmental Representative.
- .3 Keep joints and couplings free of concrete.
- .4 Do not backfill over concrete within 24 hours after placing.

- .5 For restrained joints: only use restrained joints approved by Departmental Representative.

3.10 HYDROSTATIC AND LEAKAGE TESTING

- .1 Do tests in accordance with ANSI/AWWA C600.
- .2 Provide labour, equipment and materials required to perform hydrostatic and leakage tests hereinafter described.
- .3 Notify Departmental Representative at least 24 hours in advance of proposed tests.
- .1 Perform tests in presence of Departmental Representative.
- .4 Where section of system is provided with concrete thrust blocks, conduct tests at least 5 days after placing concrete or 2 days if high early strength concrete is used.
- .5 Upon completion of pipe laying and after Departmental Representative has inspected Work in place, surround and cover pipes between joints with approved granular material placed as directed by Departmental Representative.
- Leave hydrants, valves, joints and fittings exposed.
- .6 When testing is done during freezing weather, protect hydrants, valves, joints and fittings from freezing.
- .7
- .8 Strut and brace caps, bends, tees, and valves, to prevent movement when test pressure is applied.
- Open valves.
- .9 Expel air from main by slowly filling main with potable water.
- .10 .1 Remove stops after satisfactory completion of test and seal holes with plugs.
- Thoroughly examine exposed parts and correct for leakage as necessary.
- .11 Apply hydrostatic test pressure of 1380 kPa minimum based on elevation of lowest
- .12 point in main and corrected to elevation of test gauge, for period of 1 hour.
- Examine exposed pipe, joints, fittings and appurtenances while system is under
- .13 pressure.
- Remove joints, fittings and appurtenances found defective and replace with new sound
- .14 material and make watertight.
- Repeat hydrostatic test until defects have been corrected.
- .15 Apply leakage test pressure of 690 kPa minimum after complete backfilling of trench,
- .16 based on elevation of lowest point in main and corrected to elevation of gauge, for period of 2 hours.
- Define leakage as amount of water supplied from water storage tank in order to
- .17 maintain test pressure for 2 hours.
- Do not exceed allowable leakage of 1.079 L/day/km of pipe, including lateral
- .18 connections.

- .19 Locate and repair defects if leakage is greater than amount specified.
- .20 Repeat test until leakage is within specified allowance for full length of water main.

3.11 PIPE SURROUND

- .1 Upon completion of pipe laying and after Departmental Representative has inspected Work in place, surround and cover pipes as indicated.
- .2 Hand place surround material in uniform layers not exceeding 150 mm compacted thickness as indicated.
 - .1 Do not dump material within 1 m of pipe.
- .3 Place layers uniformly and simultaneously on each side of pipe.
- .4 Do not place material in frozen condition.
- .5 Compact each layer from pipe invert to mid height of pipe to at least 95% maximum density to ASTM D698.
- .6 Compact each layer from mid height of pipe to underside of backfill to at least 90% maximum density to ASTM D 698.

3.12 BACKFILL

- .1 Place backfill material, above pipe surround, in uniform layers not exceeding 150 mm compacted thickness up to grades as indicated.
- .2 Do not place backfill in frozen condition.
- .3 Under paving and walks, compact backfill to at least 95% maximum density to ASTM D 698.
 - .1 In other areas, compact to at least 90% maximum density to ASTM D 698.

3.13 HYDRANT FLOW TESTS

- .1 Conduct flow tests on every hydrant to determine fire flows prior to painting hydrant caps and ports.

3.14 PAINTING OF HYDRANTS

- .1 After installation, paint hydrants red.
- .2 After hydrant flow tests, paint caps and ports to meet colour selections approved by authority having jurisdiction.

3.15 FLUSHING AND DISINFECTING

- .1 Flushing and disinfecting operations: witnessed by Departmental Representative.
 - .1 Notify Departmental Representative at least 4 days in advance of proposed date when disinfecting operations will begin.

- .2 Flush water mains through available outlets with a sufficient flow of potable water to produce velocity of 1.5 m/s, within pipe for minimum 10 minutes, or until foreign materials have been removed and flushed water is clear.

- .3 Flushing flows as follows:

Pipe Size NPS	Minimum Flow L/s
6 and below	38
8	75
10	115
12	150

- .4 Provide connections and pumps for flushing as required.

- .5 Open and close valves, hydrants and service connections to ensure thorough flushing.

- .6 When flushing has been completed to Departmental Representative approval, introduce strong solution of chlorine as approved by Departmental Representative into water main and ensure that it is distributed throughout entire system.

- .7 Rate of chlorine application to be proportional to rate of water entering pipe.

- .8 Chlorine application to be close to point of filling water main and to occur at same time.

- .9 Operate valves, hydrants and appurtenances while main contains chlorine solution.

- .10 Flush line to remove chlorine solution after 24 hours.

- .11 Measure chlorine residuals at extreme end of pipe-line being tested.

- .12 Perform bacteriological tests on water main, after chlorine solution has been flushed out.

- .1 .1 Take samples daily for minimum of 2 days.

- .2 .2 Should contamination remain or recur during this period, repeat disinfecting procedure.

- .13 Take water samples at hydrants and service connections, in suitable sequence, to test for chlorine residual.

- .14 After adequate chlorine residual not less than 50 ppm has been obtained leave system charged with chlorine solution for 24 hours.

- .1 .1 After 24 hours, take further samples to ensure that there is still not less than 10 ppm of chlorine residual remaining throughout system.

3.16 SURFACE RESTORATION

- .1 .1 After installing and backfilling over water mains, restore surface to original condition as directed by Departmental Representative.

3.17 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .4 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 33 00 — Submittal Procedures.
- .2 Section 01 74 21 — Construction/Demolition Waste Management and Disposal.
- .3 Section 03 30 00 — Cast in Place Concrete.
- .4 Section 31 00 99 — Earthworks for Minor Works.

1.2 REFERENCE STANDARDS

- .1 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .1 ANSI/AWWA C111/A21.11-07, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - .2 ANSI/AWWA C900-2007, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 Inch-12 Inch (100 mm-300 mm), for Water Distribution.
- .2 ASTM International
 - .1 ASTM C 12-09, Standard Practice for Installing Vitrified Clay Pipe Lines.
 - .2 ASTM C 14M-07, Standard Specification for Non-reinforced Concrete Sewer, Storm Drain and Culvert Pipe (Metric).
 - .3 ASTM C 76M-10a, Standard Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe (Metric).
 - .4 ASTM C 117-04, Standard Test Method for Material Finer Than 75 mm (No. 200) Sieve in Mineral Aggregates by Washing.
 - .5 ASTM C 136-06, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .6 ASTM C 425-09, Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
 - .7 ASTM C 428-05(2006), Standard Specification for Asbestos-Cement Non pressure Sewer Pipe.
 - .8 ASTM C 443M-07, Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric).
 - .9 ASTM C 663-98(2008), Standard Specification for Asbestos Cement Storm Drain Pipe.
 - .10 ASTM C 700-09, Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
 - .11 ASTM C 828-06, Standard Test Method for Low-pressure Air Test of Vitrified Clay Pipe Lines.

- .12 ASTM D 698-07e1, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft⁴-lbf/1U (600 kN-m/mu)).
- .13 ASTM D 1869-95(2005)e1, Standard Specification for Rubber Rings for Asbestos Cement Pipe.
- .14 ASTM D 2680-01(2009), Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.
- .15 ASTM D 3034-08, Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- .16 ASTM D 3350-10, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
- .17 ASTM F1417 (2015) - Standard Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series.
 - .2 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.
 - .3 CAN/CGSB-34.9-M94, Pipe, Asbestos Cement, Sewer.
- .4 CSA International
 - .1 CSA B1800-11, Thermoplastic Non-pressure Pipe Compendium.
 - .1 CSA B182.1-11, Plastic Drain and Sewer Pipe and Pipe Fittings.
 - .2 CSA B182.2-11, PSM Type Polyvinylchloride PVC Sewer Pipe and Fittings.
 - .3 CSA B182.6-11, Profile Polyethylene (PE) Sewer Pipe and Fittings for Leak-Proof Sewer Applications.
 - .4 CSA B182.11-11, Standard Practice for the Installation of Thermoplastic Drain, Storm, and Sewer Pipe and Fittings.
- .5 U.S. Environmental Protection Agency (EPA) / Office of Water
 - .1 EPA 832/R-92-005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Scheduling:
 - .1 Schedule Work to minimize interruptions to existing services and maintain existing sewage flows during construction.
 - .2 Submit schedule of expected interruptions for approval and adhere to approved schedule.
 - .3 Notify Departmental Representative and building 24 hours minimum in advance of any interruption in service.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Certificates:
 - .1 Certification to be marked on pipe.
- .4 Test and Evaluation Reports:
 - .1 Submit manufacturer's test data and certification 2 weeks minimum before beginning Work.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in accordance with manufacturer's recommendations.
 - .2 Store and protect pipes from damage.
 - .3 Replace defective or damaged materials with new.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

Part 2 Products

2.1 PLASTIC PIPE

- .1 Type PSM Polyvinyl Chloride (PVC): to ASTM D 3034 or CSA B182.2.
 - .1 Standard Dimensional Ratio (SDR): 41.
 - .2 Locked-in gasket and integral bell system.
 - .3 Nominal lengths: 4 m.
- .2 Acrylonitrile - Butadiene - Styrene (ABS): to ASTM D 2680 or CSA B182.2.

2.2 SERVICE CONNECTIONS

- .1 Type PSM Poly (Vinyl) Chloride: to CSA B182.2.
- .2 Plastic pipe: to CSA B182.1, with push-on joints.

- .3 Cast iron service saddles: with oil resistant gaskets, stainless steel clamp and oil resistant "O" rings in branch end.

2.3 CEMENT MORTAR

- .1 Portland cement: to CSA A3000, normal type 10.
- .2 Mix mortar 1 part by volume of cement to two parts of clean, sharp sand mixed dry.
 - .1 Add only sufficient water after mixing to give optimum consistency for placement.
 - .2 Do not use additives.

2.4 PIPE BEDDING AND SURROUND MATERIALS

- .1 Granular material to Section 31 05 16 - Aggregate Materials and following requirements:
 - .1 Crushed or screened stone, gravel or sand.
 - .2 Gradations to be within limits specified when tested to ASTM C 136 and ASTM C 117.
 - .1 Sieve sizes to CAN/CGSB-8.2.
 - .2 Table:

Sieve Size (mm)	Stone/Gravel
31.5	100
25	60-100
19	15-100
2.36	10-100
.075	0-5

- .3 Concrete mixes and materials for cradles, encasement, supports: to Section 03 30 00 - Cast-in-Place Concrete.

2.5 BACKFILL MATERIAL

- .1 As indicated.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for sewer pipe installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 PREPARATION

- .1 Clean pipes and fittings of debris and water before installation, and remove defective materials from site to approval of Departmental Representative.
- .2 Clean and dry pipes and fittings before installation.
- .3 Obtain Departmental Representative's approval of pipes and fittings prior to installation.

3.3 TRENCHING

- .1 Do trenching Work in accordance with Section 31 00 99 — Earthworks for Minor Works.
- .2 Protect trench from contents of sewer or sewer connection.
- .3 Trench alignment and depth require approval of Departmental Representative prior to placing bedding material and pipe.

3.4 GRANULAR BEDDING

- .1 Place bedding in unfrozen condition.
- .2 Place granular bedding materials in uniform layers not exceeding 150 mm compacted thickness to depth as indicated.
- .3 Shape bed true to grade and to provide continuous, uniform bearing surface for pipe.
 - .1 Do not use blocks when bedding pipe.
- .4 Shape transverse depressions as required to suit joints.
- .5 Compact each layer full width of bed to at least 95% corrected maximum dry density.
- .6 Fill excavation below bottom of specified bedding adjacent to manholes or structures with compacted bedding material.

3.5 INSTALLATION

- .1 Lay and join pipes to: ASTM C 12.
- .2 Lay and join pipes in accordance with manufacturer's recommendations and to approval of Departmental Representative.
- .3 Handle pipe using methods approved by Departmental Representative.
 - .1 Do not use chains or cables passed through rigid pipe bore so that weight of pipe bears upon pipe ends.
- .4 Lay pipes on prepared bed, true to line and grade, with pipe invert smooth and free of sags or high points.
 - .1 Ensure barrel of each pipe is in contact with shaped bed throughout its full length.
- .5 Begin laying at outlet and proceed in upstream direction with socket ends of pipe facing upgrade.
- .6 Joint deflection permitted within limits recommended by pipe manufacturer.
- .7 Water to flow through pipe during construction, only as permitted by Departmental Representative.
- .8 Whenever Work is suspended, install removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.
- .9 Install plastic pipe and fittings in accordance with CSA B182.11.
- .10 Pipe jointing:
 - .1 Install gaskets in accordance with manufacturer's written recommendations.
 - .2 Support pipes with hand slings or crane as required to minimize lateral pressure on gasket and maintain concentricity until gasket is properly positioned.
 - .3 Align pipes before joining.
 - .4 Maintain pipe joints free from mud, silt, gravel and foreign material.
 - .5 Avoid displacing gasket or contaminating with dirt or foreign material. Gaskets so disturbed to be removed, cleaned and lubricated and replaced before joining is attempted.
 - .6 Complete each joint before laying next length of pipe.
 - .7 Minimize joint deflection after joint has been made to avoid joint damage.
 - .8 At rigid structures, install pipe joints not more than 1.2 m from side of structure.
 - .9 Apply sufficient pressure in making joints to ensure that joint is complete as outlined in manufacturer's recommendations.
- .11 When stoppage of Work occurs, block pipes as directed by Departmental Representative to prevent creep during downtime.
 - .12 Plug lifting holes with pre-fabricated plugs approved by Departmental Representative, set in shrinkage compensating grout.

- .13 Cut pipes as required for special inserts, fittings or closure pieces as recommended by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.
- .14 Make watertight connections to manholes.
 - .1 Use shrinkage compensating grout when suitable gaskets are not available.
- .15 Use prefabricated saddles or field connections approved by Departmental Representative, for connecting pipes to existing sewer pipes.
 - .1 Joints to be structurally sound and watertight.

3.6 PIPE SURROUND

- .1 Place surround material in unfrozen condition.
- .2 Upon completion of pipe laying, and after Departmental Representative has inspected pipe joints, surround and cover pipes as indicated.
 - .1 Leave joints and fittings exposed until field testing is completed.
- .3 Hand place surround material in uniform layers not exceeding 200 mm compacted thickness as indicated.
 - .1 Do not dump material within 2 m of pipe.
- .4 Place layers uniformly and simultaneously on each side of pipe.
- .5 Compact each layer from pipe invert to [mid height] of pipe to at least 95% corrected maximum dry density.
- .6 Compact each layer from mid height of pipe to underside of backfill to at least 90% corrected maximum dry density.
- .7 When field test results are acceptable to Departmental Representative, place surround material at pipe joints.

3.7 BACKFILL

- .1 Place backfill material in unfrozen condition.
- .2 Place backfill material, above pipe surround in uniform layers not exceeding 200 mm compacted thickness up to grades as indicated.

3.8 SERVICE CONNECTIONS

- .1 Install pipe to CSA B182.11 and manufacturer's instructions and specifications.
- .2 Maintain grade for 100 and 150 mm diameter sewers at 2.0% minimum unless directed otherwise by Departmental Representative.
- .3 Service connections to main sewer: Wye fittings or Departmental Representative approved saddles.
 - .1 Do not use break-in and mortar patch-type joints.

- .4 Service connection pipe: not to extend into interior of main sewer.
- .5 Make up required horizontal and vertical bends from 45 degrees bends or less, separated by straight section of pipe with minimum length of 4 pipe diameters.
 - .1 Use long sweep bends where applicable.
- .6 Plug service laterals with water tight caps or plugs as approved by Departmental Representative.
- .7 Place location marker at ends of plugged or capped unconnected sewer lines.
 - .1 Each marker: 38 x 89 mm stake extending from pipe end at pipe level to 0.6 m above grade.
 - .2 Paint exposed portion of stake red with designation SAN SWR LINE in black.

3.9 FIELD TESTING

- .1 Repair or replace pipe, pipe joint or bedding found defective.
- .2 When directed by Departmental Representative, draw tapered wooden plug with diameter 95% of nominal pipe diameter through sewer to ensure that pipe is free of obstruction.
- .3 Remove foreign material from sewers and related appurtenances by flushing with water.
- .4 Perform infiltration and exfiltration testing as soon as practicable after jointing and bedding are complete, and service connections have been installed.
- .5 Do infiltration and exfiltration testing as specified herein and as directed by Departmental Representative.
 - .1 Perform tests in presence of Departmental Representative.
 - .2 Notify Departmental Representative 24 hours minimum in advance of proposed tests.
- .6 Carry out tests on each section of sewer between successive manholes including service connections.
- .7 Install watertight bulkheads in suitable manner to isolate test section from rest of pipeline.
- .8 Exfiltration Test:
 - .1 Fill test section with water to displace air in line. Maintain under nominal head for 24 hours to ensure absorption in pipe wall is complete before test measurements are begun.
 - .2 Immediately prior to test period add water to pipeline until there is head of 1 in over interior crown of pipe measured at highest point of test section or water in manhole is 1 in above static ground water level, whichever is greater.
 - .3 Duration of exfiltration test: 2 hours.
 - .4 Water loss at end of test period: not to exceed maximum allowable exfiltration over any section of pipe between manholes.

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- .9 Infiltration Test:
- .1 Conduct infiltration test in lieu of exfiltration test where static ground water level is 750 mm or more above top of pipe measured at highest point in line to be used.
 - .2 Do not interpolate a head greater than 750 mm to obtain an increase in allowable infiltration rate.
 - .3 Install watertight plug at upstream end of pipeline test section.
 - .4 Discontinue pumping operations for at least 3 days before test measurements are to begin and during this time, keep thoroughly wet at least one third of pipe invert perimeter.
 - .5 Prevent damage to pipe and bedding material due to flotation and erosion.
 - .6 Place 90 degrees V-notch weir, or other measuring device approved by Departmental Representative in invert of sewer at each manhole.
 - .7 Measure rate of flow over minimum of 1 hour, with recorded flows for each 5 min interval.
- .10 Leakage: not to exceed following limits in litres per hour per mm of diameter per 100m of sewer including service connections:
- .1 Exfiltration, based on 600 mm head: 0.175 L.
 - .2 Infiltration: 0.150 L.
- .11 Low Pressure Air Test:
- .1 Perform in accordance with ASTM F1417 and UNI B-6-90,
 - .2 Equipment:
 - .1 Provided by Contractor.
 - .2 Properly calibrated and oil-free.
 - .3 Provide separate lines for:
 - .1 Introduction of low pressure air.
 - .2 Constant monitoring of air pressure build-up in line.
 - .3 Inflation of pneumatic plugs from the control panel.
 - .4 Mechanical or pneumatic plugs may be used to isolate pipe sections.
 - .5 Procedure:
 - .1 Ensure lines have been flushed and video inspected prior to beginning low pressure air test.
 - .2 Isolate sewer line to be tested with plugs.
 - .1 Inspect manhole inverts for damage prior to installing plug.
 - .3 Conduct for time duration: $T \text{ (seconds)} = 0.085DK/Q$
 $K = 0.000419DL$, but not less than 1.0
 $Q = 0.0015 \text{ ft}^3/\text{in/square foot internal pipe surface area}$
 $D = \text{nominal pipe diameter in inches}$
 $L = \text{length of pipe being tested in feet}$

- .1 Minimum time (min:sec):
 - .1 100mm dia — 3:46
 - .2 150mm dia — 5:40
 - .3 200mm dia — 7:34
 - .4 250mm dia — 11:20
- .4 Connect air source to inlet tap and slowly add air until pressure equals 4.0 psig greater than the average back pressure from groundwater.
 - .1 Do not exceed 9.0 psig.
- .5 Control pressure to maintain pressure for minimum 2 minutes until pressure stabilizes.
- .6 Disconnect air supply and decrease pressure slightly to range: 3.5 psig — 4.0 psig greater than the average back pressure from groundwater.
- .7 Begin timing test.
- .8 Record pressure following T seconds.
- .9 Test fails if pressure drop of 1.0 psig or greater occurs.
- .12 Repair and retest sewer line as required, until test results are within limits specified.
- .13 Repair visible leaks regardless of test results.
- .14 Television and photographic inspections:
 - .1 Carry out inspection of installed sewers by video camera, digital camera or by other related means.
 - .2 Provide means of access to permit Departmental Representative to do inspections.

3.10 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 33 00 — Submittal Procedures.
- .2 Section 01 74 21 — Construction/Demolition Waste Management and Disposal.
- .3 Section 03 30 00 — Cast in Place Concrete.
- .4 Section 31 00 99 — Earthworks for Minor Works.

1.2 REFERENCE STANDARDS

- .1 ASTM International
 - .1 ASTM C 117-04, Standard Test Method for Material Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.
 - .2 ASTM C 136-06, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .3 ASTM D1557-12, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort.
 - .4 ASTM D 2680-01(2009), Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.
 - .5 ASTM D 3034-08, Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
 - .6 ASTM F 405-05, Standard Specification for Corrugated Polyethylene (PE) Tubing and Fittings.
 - .7 ASTM F 667-06, Standard Specification for Large Diameter Corrugated Polyethylene Tubing and Fittings.
 - .8 ASTM F 794-03(2009), Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
 - .9 ASTM F 1417 (2015) - Standard Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.
 - .2 CAN/CGSB-34.9-94, Asbestos-Cement Sewer Pipe.
- .3 CSA International
 - .1 CAN/CSA-A3000-08, Cementitious Materials Compendium.
 - .2 CSA G401-07, Corrugated Steel Pipe Products.

1.3 SCHEDULING

- .1 Schedule Work to minimize interruptions to existing services and to maintain existing flow during construction.

- .2 Submit schedule of expected interruptions for approval and adhere to approved schedule.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00-Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Samples:
 - .1 Inform Departmental Representative at least 4 weeks prior to beginning Work, of proposed source of bedding materials and provide access for sampling.
- .4 Certification to be marked on pipe.
- .5 Test and Evaluation Reports: submit manufacturer's test data and certification at least 2 weeks prior to beginning Work.
- .6 Manufacturer's Instructions: submit to Departmental Representative 1 copy of manufacturer's installation instructions.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in accordance with manufacturer's recommendations.
 - .2 Store and protect pipes from damage.
 - .3 Replace defective or damaged materials with new.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

Part 2 Products

2.1 PLASTIC PIPE

- .1 Type PSM Poly Vinyl Chloride (PVC): to ASTM D 3034 or CAN/CSA-B1800.

- .1 Standard Dimensional Ratio (SDR): 35.
- .2 Locked-in gasket and integral bell system.
- .3 Nominal lengths: 4 m.
- .2 Large diameter, ribbed PVC sewer pipe and fittings: to ASTM F 794 or CAN/CSA-B1800.
- .3 Acrylonitrile - Butadiene - Styrene (ABS): to ASTM D 2680 or CAN/CSA-B1800.

2.2 CORRUGATED DOUBLE WALLED HDPE PIPE

- .1 Double Walled Corrugated High Density Polyethylene (HDPE): to ASTM D3350 or CSA-B182.6.
 - .1 Loading: HS-25 rated with minimum cover of 300mm
 - .2 Stiffness: 320 kPa to ASTM D 2412
 - .3 Joining System: Water Tight
 - .1 To CSA B182.g, Type 1
 - .2 To meet 74 kPa water pressure / vacuum lab testing requirements
 - .3 Gaskets to be polyisoprene meeting the requirements of ASTM F477
 - .4 Gaskets to be covered with a removable, protective wrap.
 - .5 300 to 1500 mm pipe to have a reinforced bell with a polymer composite band installed by the manufacturer.
 - .4 Fittings:
 - .1 All fabricated fittings and couplings supplied by the manufacturer shall be constructed to ensure no loss of structural integrity or joint tightness at joints.
 - .2 Only those fittings supplied by or recommended by the manufacturer shall be used.
- .2 Applicable Standards
 - .1 CSA B182.8

2.3 STEEL REINFORCED POLYETHYLENE PIPE

- .1 Steel Reinforced polyethylene pipe (SRPE): to ASTM F2562, Standard Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage.
 - .1 Resin:
 - .1 Conforms to ASTM D3350-12, Standard Specification for Polyethylene Plastics Pipe and Fitting Materials.
 - .2 Fittings:
 - .1 All fabricated fittings and couplings supplied by the manufacturer shall be constructed to ensure no loss of structural integrity or joint tightness at joints.

- .2 Only those fittings supplied by or recommended by the manufacturer shall be used.
- .3 Reinforcing Steel:
 - .1 550 kPa steel reinforcing.

2.4 PIPE BEDDING AND SURROUND MATERIAL

- .1 Granular material in accordance with Section 31 00 99 — Earthworks for Minor Works and following requirements:
 - .1 Crushed or screened stone, gravel or sand.
 - .2 Gradations to be within limits specified when tested to ASTM C 136 and ASTM C 117. Sieve sizes to CAN/CGSB-8.2.
- .2 Table:

Sieve Size (mm)	Stone/Gravel
31.5	100
25	60-100
19	15-100
2.36	10-100
.075	0-5

- .3 Concrete mixes and materials for thrust blocks in accordance with Section 03 3000 - Cast-in-Place Concrete.

2.5 BACKFILL MATERIAL

- .1 Per section 31 00 99 — Earthworks for Minor Works

2.6 JOINT MORTAR

- .1 Portland cement: to CAN/CSA-A3000, normal type 10.
- .2 Mortar: one part Portland cement to two parts clean sharp sand mixed with minimum amount of water to obtain optimum consistency for use intended. Do not use additives.

Part 3 Execution

3.1 PREPARATION

- .1 Clean pipes and fittings of debris and water before installation, and remove defective materials from site to approval of Departmental Representative.

3.2 TRENCHING

- .1 Do trenching Work in accordance with Section 31 00 99 — Earthworks for Minor Works
- .2 Protect trench from contents of sewer.

- .3 Trench alignment and depth to approval of Departmental Representative prior to placing bedding material and pipe.
- .4 Waterjetting of backfill under haunches of corrugated steel pipe may be permitted if recommended by manufacturer and approved by Departmental Representative.

3.3 GRANULAR BEDDING

- .1 Place bedding in unfrozen condition.
- .2 Place granular bedding material in uniform layers not exceeding 150 mm compacted thickness to depth as indicated.
- .3 Shape bed true to grade and to provide continuous, uniform bearing surface for pipe.
 - .1 Do not use blocks when bedding pipes.
- .4 Shape transverse depressions as required to suit joints.
- .5 Compact each layer full width of bed to at least 95 % Modified Proctor Density in compliance with ASTM D1557.
- .6 Fill excavation below bottom of specified bedding adjacent to manholes or catch basins with compacted bedding material.

3.4 INSTALLATION

- .1 Lay and join pipe in accordance with manufacturer's recommendations and to approval of Departmental Representative.
 - .1 Do not use chains or cables passed through rigid pipe bore so that weight of pipe bears upon pipe ends.
- .2 Lay pipes on prepared bed, true to line and grade with pipe inverts smooth and free of sags or high points.
 - .1 Ensure barrel of each pipe is in contact with shaped bed throughout its full length.
- .3 Begin laying at outlet and proceed in upstream direction with socket ends of pipe facing upgrade.
- .4 Install Pipes to the following tolerances:
 - .1 Horizontal tolerances: plus or minus 50 mm from specified alignment.
 - .2 Vertical tolerances: plus or minus 10 mm from specified grade. Reverse grade is not acceptable
- .5 Joints:
 - .1 Install gaskets as recommended by manufacturer on all pipe unless specified otherwise.
 - .2 Support pipes with hand slings or crane as required to minimize lateral pressure on gasket and maintain concentricity until gasket is properly positioned.
 - .3 Align pipes carefully before joining.

- .4 Maintain pipe joints free from mud, silt, gravel and other foreign material.
- .5 Avoid displacing gasket or contaminating with dirt or other foreign material. Remove disturbed or dirty gaskets; clean, lubricate and replace before joining is attempted.
- .6 Complete each joint before laying next length of pipe.
- .7 Minimize joint deflection after joint has been made to avoid joint damage.
- .8 Apply sufficient pressure in making joints to ensure that joint is complete as outlined in manufacturer's recommendations.
- .6 Joint deflection permitted within limits recommended by pipe manufacturer.
- .7 Whenever Work is suspended, install removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.
- .8 When any stoppage of Work occurs, restrain pipes as directed by Departmental Representative, to prevent "creep" during down time.
- .9 Plug lifting holes with Departmental Representative approved prefabricated plugs, set in shrinkage compensating grout.
- .10 Cut pipes as required for special inserts as recommended by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.
- .11 Make watertight connections to manholes and catch basins.
- .1 Use shrinkage compensating grout when suitable gaskets are not available.

3.5

PIPE SURROUND

- .1 Place surround material in unfrozen condition.
- .2 Upon completion of pipe laying, and after Departmental Representative has inspected pipe joints, surround and cover pipes as indicated.
 - .1 Leave joints and fittings exposed until field testing is completed.
- .3 Hand place surround material in uniform layers not exceeding 150 mm compacted thickness as indicated.
 - .1 Do not dump material within 1 m of pipe.
- .4 Place layers uniformly and simultaneously on each side of pipe.
- .5 Compact each layer from pipe invert to underside of pipe to at least 95 % Modified Proctor.
- .6 When field test results are acceptable to Departmental Representative, place surround material at pipe joints.
- .7 Surround material should be compacted with a hand compactor.

3.6

BACKFILL

- .1 Place backfill material in unfrozen condition.

- .2 Place backfill material, above pipe surround in uniform layers not exceeding 200 mm compacted thickness up to grades as indicated.

- .3 Per section 31 00 99 — Earthworks for Minor Works.

3.7 FIELD TESTS AND INSPECTIONS

- .1 Perform infiltration and exfiltration testing as soon as practicable after jointing and bedding are complete, and service connections have been installed.
- .2 Do infiltration and exfiltration testing as specified herein and as directed by Departmental Representative.
 - .1 Perform tests in presence of Departmental Representative.
 - .2 Notify Departmental Representative 24 hours in advance of proposed tests.
- .3 Carry out tests on each section of sewer between successive manholes including service connections.
- .4 Install watertight bulkheads in suitable manner to isolate test section from rest of pipeline.
- .5 Exfiltration test.
 - .1 Fill test section with water to displace air in line. Maintain under nominal head for 24 hours to ensure absorption in pipe wall is complete before test measurements are begun.
 - .2 Immediately prior to test period add water to pipeline until there is head of 1 m over interior crown of pipe measured at highest point of test section or water in manhole is 1 m above static ground water level, whichever is greater.
 - .3 Duration of exfiltration test: 2 hours.
 - .4 Water loss at end of test period: not to exceed maximum allowable exfiltration over any section of pipe between manholes.
- .6 Infiltration test.
 - .1 Conduct infiltration test in lieu of exfiltration test where static ground water level is 750 mm or more above top of pipe measured at highest point in line to be used.
 - .2 Do not interpolate a head greater than 750 mm to obtain an increase in allowable infiltration rate.
 - .3 Install watertight plug at upstream end of pipeline test section.
 - .4 Discontinue pumping operations for at least 3 days before test measurements are to begin and during this time, keep thoroughly wet at least one third of pipe invert perimeter.
 - .5 Prevent damage to pipe and bedding material due to flotation and erosion.
 - .6 Place 90 degrees V-notch weir, or other measuring device approved by Departmental Representative in invert of sewer at each manhole.

- .7 Measure rate of flow over minimum of 1 hour, with recorded flows for each 5 min interval.
- .7 Leakage: not to exceed following limits in litres per hour per mm of diameter per 100 m of sewer including service connections.
 - .1 Exfiltration, based on 600 mm head: 0.175 L.
 - .2 Infiltration: 0.150 L.
- .8 Low Pressure Air Test:
 - .1 Perform in accordance with ASTM F1417 and UNI B-6-90.
 - .2 Equipment:
 - .1 Provided by Contractor.
 - .2 Properly calibrated and oil-free.
 - .3 Provide separate lines for:
 - .1 Introduction of low pressure air.
 - .2 Constant monitoring of air pressure build-up in line.
 - .3 Inflation of pneumatic plugs from the control panel.
 - .4 Mechanical or pneumatic plugs may be used to isolate pipe sections.
 - .5 Procedure:
 - .1 Ensure lines have been flushed and video inspected prior to beginning low pressure air test.
 - .2 Isolate sewer line to be tested with plugs.
 - .1 Inspect manhole inverts for damage prior to installing plug.
 - .3 Conduct for time duration: $T \text{ (seconds)} = 0.085DK/Q$
 $K = 0.000419DL$, but not less than 1.0
 $Q = 0.0015 \text{ ft}^3$ in/square foot internal pipe surface area
 D = nominal pipe diameter in inches
 L = length of pipe being tested in feet
 - .1 Minimum time (min:sec):
 - .1 100mm dia — 3:46
 - .2 150mm dia — 5:40
 - .3 200mm dia — 7:34
 - .4 250mm dia — 11:20
 - .4 Connect air source to inlet tap and slowly add air until pressure equals 4.0 psig greater than the average back pressure from groundwater.
 - .1 Do not exceed 9.0 psig.
 - .5 Control pressure to maintain pressure for minimum 2 minutes until pressure stabilizes.
 - .6 Disconnect air supply and decrease pressure slightly to range: 3.5 psig — 4.0 psig greater than the average back pressure from groundwater.

- .7 Begin timing test.
- .8 Record pressure following T seconds.
- .6 Test fails if pressure drop of 1.0 psig or greater occurs.
- .9 Repair and retest sewer line as required, until test results are within limits specified.
- .10 Repair visible leaks regardless of test results.

3.8 VIDEO INSPECTION

- .1 The Contractor shall video inspect completed storm sewers following completion of installation. The video inspection report shall be in the form specified in Section 01 33 00 — Submittal Procedures.
- .2 Should video inspection indicate apparent deficiencies, the Departmental Representative may direct Contractor to perform additional testing.

3.9 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility,

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 35 43 — Environmental Procedures
- .2 Section 31 00 99 — Earthworks for Minor Works
- .3 Section 31 37 00 — Rip Rap
- .4 Section 32 92 10.16 — Hydraulic Seeding

1.2 ENVIRONMENTAL REQUIREMENTS

- .1 Operation of construction equipment in water is prohibited.
- .2 Use borrow material from watercourse beds only after receipt of written approval from Departmental Representative and authority having jurisdiction.
- .3 Design and construct temporary crossings to minimize environmental impact to watercourse and wetland.
- .4 Constructing temporary crossings of watercourses where spawning beds are indicated is prohibited.
- .5 Dumping excavated fill, waste material, or debris in watercourse or wetland is prohibited.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit conceptual intercepted water management plan in accordance with Section 01 35 43 — Environmental Procedures.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 EXISTING CONDITIONS

- .1 Maintain existing flow pattern in natural watercourse systems.
- .2 In natural systems maintain existing riffle pool and step pool patterns.
- .3 In wetland systems, maintain existing hydrological conditions.

3.2 SITE CLEARING AND PLANT PROTECTION

.1 Temporary Erosion and Sedimentation Control:

- .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.
- .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
- .4 Temporary Erosion and Sedimentation Control to be implemented in accordance with Section 01 35 43 — Environmental Procedures.

.2 Minimize disturbance to vegetated buffer zones and protect trees and plants on site and adjacent properties where indicated.

.3 Wrap trees and shrubs adjacent to construction work, storage areas and trucking lanes in burlap.

.4 Protect roots of designated trees to dripline during excavation and site grading to prevent disturbance or damage.

- .1 Avoid unnecessary traffic, dumping and storage of materials over root zones.

.5 Leave cuttings from trees and other vegetation on site as brush piles as habitat structure and to allow for natural degradation.

- .1 Secure large piles with degradable materials to prevent interference with watercourse.

.6 Remove only trees that may offer future blockage problems as instructed by Departmental Representative.

Leave root mass and stumps in place.

.7 Maintain temporary erosion and pollution control features installed under this contract.

3.3 FISH AND WILDLIFE PROTECTION

- .1 Allow Parks Canada or qualified professionals designated by Departmental Representative to conduct fish and/or wildlife salvage prior to and during instream works. Notify the Departmental Representative a minimum of two calendar weeks in advance of such activities so that the Departmental Representative can coordinate fish and wildlife salvage.

3.4 TEMPORARY STREAM DIVERSION AND DISCHARGE

- .1 Methods of stream diversion include dam and pump, and dam and flume.

- .2 Fish salvage must occur prior to de-watering of work areas.

- .3 Adequately sized pump(s) shall be used to accommodate flows up to bankfull.
- .4 Electric pumps are preferred to gasoline pumps at sites with access to a nearby source of electricity. Back-up pumps must be kept on-site in case of pump failure.
- .5 Ensure pump inlet(s) is protected using an appropriately designed and sized fixed screen or other device to prevent debris blockage and fish entrainment. Screens may need to be designed and fabricated to be "fit for purpose". DFO's "Freshwater Intake End-of-Pipe Fish Screen Guideline" provides further guidance.
- .6 Create an energy dissipation structure (rock pad or equivalent) at water discharge points as directed by Departmental Representative to prevent in-channel or bank scour and erosion and to accommodate safe surface water entry to watercourse.
- .7 Install pump inlets in a deep portion of the channel or construct a depression to ensure the inlet is completely submerged at all times. Clean water may be pumped directly into the receiving water body if no scour potential.
- .8 The pumping of turbid water directly back into the waterbody is not permitted. Water exceeding the following performance criteria must be treated or managed appropriately:
 - .1 Maximum increase of suspended sediment concentration shall not be more than 25 mg/L over background levels during any short term exposure period (i.e., 24 hours). For longer term operations (i.e., more than 30 days), average suspended sediment concentrations shall not be increased by more than 5 mg/L over background levels.
 - .2 Maximum increase of 8 NTU from background levels for a short-term exposure (i.e., 24 hours). Maximum average increase of 2 NTU from background levels for a longer term exposure (e.g., more than 30 days).
- .9 Install a dam across the channel to prevent flow from entering the work site. Suitable dams include aqua-dams, pea gravel bags, concrete block dams, steel or wood wall. The placement of rocks or sheet piling in the watercourse is not appropriate for dam and pump operations with a short duration. Use of loose aggregate should be avoided. If required install a downstream dam to prevent backwatering into the work area.
- .10 If flume is preferred, then install flume(s) of adequate size to accommodate flows up to bankfull. Flumes must be sized at minimum to minimize headwater depths. Excessive headwater (inlet) depths as a result of undersized flumes can put excessive pressure on isolation dams and result in overtopping in to the work area.
- .11 Determining flume capacity and technical design of this procedure shall be completed by a qualified professional retained by the Contractor.
- .12 Begin pumping and allow gravity to passively dewater the work area. A second pump may be required to keep the worksite dry.
- .13 Pumping water containing suspended materials into watercourse is prohibited.
- .13 Remove, treat and discharge residual non-contaminated discharge water in accordance with Section 01 35 43 — Environmental Procedures.

- .14 Maintain downstream flow at all times and restore original flow as soon as work is completed.
- .15 Once the works have been completed, water shall be diverted back to the channel by removing the downstream followed by the upstream dam. Pump intakes are removed last.
- .16 Restore work site to prevent ongoing erosion.

3.5 SITE RESTORATION

- .1 Establish vegetated buffer zones with suitable vegetation to minimum 3 m along edge of watercourse banks as determined by Departmental Representative.
- .2 Plant vegetation natural to area, suitable for application without requirement for fertilizers, pesticides and other chemicals.
- .3 Control stream bank erosion in lower section of watercourse with irregular shaped rip rap underlain with non-toxic filter cloth of size approved by Departmental Representative.
- .4 Hydromulching shall be used on steep slopes greater than 2:1 where seedbed cannot be prepared properly and may retain large clods of soil or rocks, and on sites where other soil stabilizing, seeding, and mulching practices would not be effective due to unacceptable levels of surface soil disturbance.
- .5 Revegetation of all exposed soils shall be undertaken using native seed mixes appropriate for local riparian areas, as soon as practicable, to reduce the risk of soil erosion and sedimentation.
- .6 Ensure planting occurs within 7 days after work on watercourse is complete.

END OF SECTION

1. GENERAL

1.1 RELATED REQUIREMENTS

- .1 Refer to Division 1, General Requirements.
- .2 All contract documents form an integral part of this section

1.2 DESCRIPTION

- .1 This section specifies requirements for the landscape maintenance during the post-construction maintenance period. The intent of establishment services is to provide sufficient care to newly installed plant material to ensure or increase the long-term success of the planting. The objective is the adaptation of plants to a new site in order to obtain the desired effect from the planting while reducing the rate of failure and unnecessary work associated with improper establishment. Establishment Services procedures apply to all plant material including new trees, shrubs and groundcovers, herbaceous plants and sodded and seeded grasses.

1.3 MAINTENANCE PERIOD

- .1 This section describes establishment services requirements from the date of Substantial Completion and for the duration of one 1 full year
- .2 Landscape maintenance requirements during the construction period prior to Substantial Completion shall commence at the time of installation and shall ensure the validity of any guarantee under the General Conditions.
- .3 The establishment services are in addition to and not a limitation of, the Contractor's responsibilities, warranties or guarantees assumed by the Contractor under the contract documents and General Conditions.
- .4 Establishment services shall apply to all landscape areas within the limits of work, as established in the contract documents or as determined on site.

1.4 RELATED SECTIONS

- .1 This specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
- .2 32 90 00 - Tree, Shrub & Groundcover Planting
- .3 32 91 21 – Growing Medium Preparation and Placement
- .4 32 92 24 - Hydraulic Seeding

1.5 REFERENCE STANDARDS AND LEGISLATION

- .1 ANSI A300 Standards for Tree, Shrub, and Woody Plant Maintenance, latest edition.
- .2 BC Landscape Standard, 7th Edition
- .3 Plant Health Care for Woody Ornamentals, International Society of Arboriculture.
- .4 Canadian Standard for Nursery Stock, Latest Edition.

- .5 Canadian Fertilizer Code
- .6 Pesticide Control Act
- .7 Federal, Provincial and Municipal laws, bylaws and regulations. All work shall be performed in accordance with regulations of any and all authorities having jurisdiction, which may restrict or prohibit certain activities such as pesticide or herbicide applications.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver and store fertilizer, seed and chemicals in waterproof containers showing contents, mass, analysis, and name of manufacturer.

1.7 DAMAGE TO PROPERTY

- .1 The Contractor shall repair and pay for damages caused by Contractor's personnel and equipment during the term of the contract.
- .2 The Contractor shall report damages immediately to the Departmental Representative.
- .3 Within three (3) days of any damages, return grass areas, plant materials, equipment, and any other property to their original condition prior to damage. Scalping of turf and mechanical damage to trees, including tearing of bark, shall be considered as damage.

1.8 HOURS OF WORK

- .1 Perform maintenance work during regular hours of 7:00 to 18:00, Monday to Friday.
- .2 Obtain Owner's and regulatory authority's approval and required permits to do maintenance outside of regular working hours.

1.9 MAINTENANCE LOG

- .1 Keep daily maintenance log throughout duration of the contract.
- .2 Include in log: detail activities, areas in which activities were carried out, and approximate time for start-up and completion of each log.
- .3 For each billing period attach maintenance log to invoice. Maintenance logs to be submitted monthly during maintenance season.
- .4 Establishment maintenance shall be carried out year-round and at times and seasons appropriate to each specific task.

1.10 FIELD REVIEWS

- .1 During the establishment period the Owner's authorized representative shall perform monthly field inspections. Field review reports, indicating deficiency and action items shall be forwarded in a timely manner to the Contractor.
- .2 The Contractor shall correct all deficiencies during the next reporting period. Actions taken shall appear in the maintenance log as additional items.
- .3 In addition to the above inspections, there shall be a minimum of three (3) field reviews during each growing season (April 1st to October 15th), attended by the Owner's and the Contractor's authorized representatives.

1.11 FAILURE TO PERFORM SERVICES

- .1 If establishment services are not performed according to this Specification, the Owner reserves the right, after seven (7) days written notice to the Contractor, to proceed with the required services and deduct actual costs from payments to the Contractor.

2. PRODUCTS

2.1 GENERAL

- .1 Products and materials, including plant material, growing medium, mulch etc. shall be as specified in other sections of this Specification.

2.2 FERTILIZERS AND CHEMICAL CONTROL

- .1 Use of "weed and feed" products or fertilizers containing phosphates is not permitted.
- .2 Apply nutrients and soil amendments as required and as indicated by plant condition, or as determined by soils analysis.

2.3 PEST AND DISEASE CONTROL

- .1 Only as specifically reviewed and approved by the Owner and in strict accordance with regulations of all authorities having jurisdiction.
- .2 The Contractor shall provide the Owner with at least seven (7) days advance notification of intent, methodology and procedures for weed and insect control.

3. EXECUTION

3.1 GENERAL

- .1 Schedule timing of operations and use of site in such manner as to avoid conflicts with regular use.
- .2 Do each operation continuously and complete all work within a reasonable time period.
- .3 Perform all maintenance including, but not limited to, the work in this specification to keep all areas neat, clean, and in healthy growing condition.
- .4 The Owner or Owner's authorized representative shall be the sole judge in determining an acceptable level of maintenance.
- .5 Collect and dispose of excess material and debris to an approved disposal facility weekly, or recycle as appropriate.
- .6 Provide all equipment and material necessary for maintenance to acceptable horticultural standards.
- .7 Report vandalism or other third-party damage immediately to the Owner.
- .8 Maintain and submit a maintenance log for each project showing maintenance activities performed and date of activities. Submit maintenance log monthly, as well as with each invoice.
- .9 Scheduling: Establishment Services operations shall be carried out year-round.

3.2 PLANT REPAIR AND REPLACEMENTS

- .1 Planting:
 - .1 Remove and replace dead, diseased or damaged plant material (trees, shrubs, groundcovers and perennials) on a yearly basis.
 - .2 All replacement plant material to be of the same species and of the same size or caliper as originally specified in the contract documents.
 - .3 Plant substitutions must be approved by the Departmental Representative prior to planting. Provide a list of plant substitutions seven (7) days prior to ordering, for Departmental Representative's review.

3.3 FERTILIZING

- .1 Lawn areas:
 - .1 Apply fertilizer three times yearly: Spring (March 15-April 15), early summer (during the month of June) and late summer (late August-September 15).
 - .2 Use mechanical spreading equipment. Apply at a rate recommended by soil testing agency. Check calibration to ensure specified rate is spread evenly.
 - .3 Rectify uneven spreading as soon as it becomes apparent. Spread additional fertilizer over areas affected or rake out excess application.
- .2 Planting beds:
 - .1 Apply fertilizer in April at rate recommended by soil testing agency.
 - .2 Fertilizer Application - Trees: Auger 25 mm (1") diameter by 300 (12") to 375 (15") deep holes, starting at drip line of branches and working towards the tree trunk. Auger holes to come within 300 mm (12") of trunk. Auger holes to be at one (1) foot on centre. Divide fertilizer equally among all holes and water in well. Top dress hole with growing medium.
 - .3 Fertilizer Application - Shrubs: Apply fertilizer as per manufacturer's recommendations to all shrub beds.

3.4 WATERING AND IRRIGATION

- .1 During the first growing season, new plants shall be watered at least every ten (10) days between April 1st and July 31st, and every twenty (20) days between August 1st and September 15th.
- .2 During the second growing season, new plants shall be watered at least every twenty (20) days between April 1st and July 31st and once between August 1st and September 15th.
- .3 Soil moisture shall be monitored during the growing season, and watering shall be done more frequently when plants are reaching the permanent wilting point. Scheduled applications of water shall be missed only when rainfall has penetrated the soil fully as required.

- .4 Apply sufficient water to ensure continuous, healthy growth of all plant materials, with sufficient time between water applications to promote deep root growth. Apply water in soft spray to avoid compacting or erosion of soil. Do not impede use of sidewalks and other paved areas.
- .5 Areas with no underground irrigation systems: supply labour, hoses and sprinkler equipment necessary to provide adequate watering.

3.5 MULCHING

- .1 Mulching shall be performed during the month of May. Prior to topping up and adding additional mulch ensure litter and debris has been removed from all planting beds
- .2 Mulches shall be maintained in the original areas and to the original depths.
- .3 Mulch products shall conform to Specification 32 90 00 - Tree, Shrub & Groundcover Planting.

3.6 CULTIVATING SHRUB AREAS

- .1 Prior to cultivating shrub areas, collect and dispose of all litter, debris and dead plant material, such as branches, leaves, flowers and seed pods.
- .2 Cultivate shrub beds as required to keep top layer of growing medium, loose, friable and free from weeds. Cultivating operation must be continuous without interruption.
- .3 Take care not to damage roots of shrubs or flowers. Use small hand tools for flower borders and areas of closely planted shrubs.

3.7 STAKING AND GUYING

- .1 Maintain all stakes, guy wires and ties for duration of the maintenance period.
- .2 Ties shall be checked at least every four months to ensure that they are not causing a depression in the bark, and shall be loosened, repaired or replaced as necessary.
- .3 All stakes, guy wires and ties shall be removed after the second growing season except where large trees require continuing support

3.8 PRUNING

- .1 All trees and shrubs shall be inspected at least every two months during the growing season and shall be pruned to remove all dead, weak or diseased wood.
- .2 Pruning shall be scheduled and carried out during times of year that are optimal for each plant species.
- .3 All pruning tasks shall be performed by experienced personnel, under the direct supervision of an I.S.A. Certified Arborist.
- .4 Prune all plant material in accordance with ANSI A300 Standards, latest edition.

3.9 WEED AND INVASIVE CONTROL

- .1 Definition: In this specification, a "weed" is defined as any plant growing where it is not wanted. This definition includes unwanted plants in planting beds, unplanted areas and

paving, as well as invasive weeds which are rapidly spreading non-native plants. This definition also includes grass varieties that detract from the desired appearance or function of sodded or hydroseeded areas.

- .2 During the growing season, all planted areas shall have all weeds (roots and rhizomes included) removed and disposed of, a minimum of once per month, or as necessary to maintain the specified weed control standard for planted areas. Weeds shall be removed by hand pulling or digging and, if necessary, by the use of systemic herbicides, to achieve and complete removal of plant structure. All applications of systemic herbicides must be reported to the Owner prior to application. All federal, provincial, municipal and regional district legislation must be adhered to. Notification of herbicide application must be posted throughout the site three (3) working days prior to application. Cultivation and hoeing shall not be used to control weeds, as these practices disturb mulch layer and soil structure, and do not adequately control weeds.
- .3 Weed control consists of: killing weeds; removing and properly disposing of weeds; encouraging the growth of desired plants that can compete with weeds; reducing the growth rate of weeds; preventing or reducing the entrance of weeds into the area; and preventing or reducing the spread of weeds by roots, seeds or runners within the area and into other areas.
- .4 Weed control operations shall be scheduled and carried out such that the spread of weeds by seed, roots, runners, etc. is minimized.
- .5 Agricultural Canada defines some weed varieties as "noxious weeds" and has formulated regulations to control their spread. These regulations shall be followed during all maintenance work.
- .6 Weed control operations shall be carried out in accordance to the following Weed Control Standards table. Maintenance level for each planted area within the scope of work shall be determined by the Owner.

WEED CONTROL STANDARDS	
Maintenance Level	Standard
1. WELL-GROOMED	No weeds permitted to grow larger than 25 mm (1") in width or height; remove all weeds when observed. The ability to perform weed control (both mechanical and chemical) must be present during each visit.
2. GROOMED	No weeds are permitted to grow larger than 50 mm (2") in width or height. Kill or remove all apparent weeds when observed or at next regular visit (within two weeks). The ability to perform weed control (both mechanical and chemical) must be present during every second visit.
3. MODERATE	Weeding must be done when isolated small weed patches have a width or height of 150 mm (6"). Weeding (mechanical or chemical) shall kill or remove 90% of weeds or the process shall be repeated within the next two site visits. <i>NOTE: "isolated" means a weed distribution no greater than two patches per 5 m².</i>

4. OPEN SPACE/PLAY	Weeding must be done when isolated weedy patches have a width or height of 300 mm (12"). Weeding (mechanical or chemical) shall kill or remove 80% of weeds or the process shall be repeated within one month. <i>NOTE: "isolated" means a weed distribution no greater than four patches per 5 m² (54 square feet).</i>
5. BACKGROUND and 6. SERVICE & INDUSTRIAL	No limitations on weeds, except that spread of weeds and (especially noxious weeds) to adjacent areas must be prevented. Control height and spread to prevent interference with activities. If better appearance is desired upgrade to Level 4.

- .7 The following is a partial list of species that are of particular concern and are to be removed immediately. Removal is not limited to this list. Consult with Owner's representative.

- | | | |
|----|--------------------------------|------------------------|
| .1 | <i>Convolvulus arvensis</i> | (Field Bindweed) |
| .2 | <i>Polygonum cuspidatum</i> | (False Bamboo) |
| .3 | <i>Rubus procerus</i> | (Himalayan Blackberry) |
| .4 | <i>Hedera helix</i> | (English Ivy) |
| .5 | <i>Ilex sp.</i> | (Holly) |
| .6 | <i>Polygonum cuspidatum</i> | (Japanese Knotweed) |
| .7 | <i>Heracleum mantegazzinum</i> | (Giant Hogweed) |

3.10 VOLUNTEER NATIVE PLANTS

- .1 As directed by the Owner's representative, volunteer native plant species that self-propagate either through seed, rhizomes or spores, shall be allowed to establish and be given the same care as installed plants

3.11 PEST AND DISEASE CONTROL

- .1 All planted areas shall be inspected for pests and diseases periodically and at least every two months during the growing season. Treatment for pests or diseases shall be carried out promptly and consistently for maximum effectiveness. The principles of Integrated Pest Management (IPM) shall be applied in controlling pests and diseases, that is, methods used should be a combination of physical, cultural, biological and chemical methods chosen for the most effective, safe and economical control of pests and diseases. Pest management plan must be approved by the Owner prior to implementation
- .2 Perform pest and disease control in accordance with all applicable chemical application regulations.

- .3 Confirm proper, positive identification of infestations and consult with Owner before taking corrective action.
- .4 Strictly adhere to manufacturer's specifications if chemical applications are being utilized.
- .5 Determine susceptibility of plant species to chemical damage prior to any chemical application.
- .6 Perform treatments with due regard for climactic conditions, the public, and the surroundings.
- .7 Repair and pay for damages caused by chemical applications.

3.12 LITTER REMOVAL

- .1 All non-vegetative litter and refuse within the maintenance area must be collected and disposed of. General litter removal shall be a routine part of maintenance.
- .2 Vegetative litter (eg. fallen leaves, twigs, trimmings) must be removed from planted areas only in a scheduled procedure before it rots or accumulates sufficiently to detract from the use or appearance of the area or damages the landscape.
- .3 Vegetative litter should be composted for re-use on site or off site where possible, or disposed of in an appropriate manner.

3.13 REPORTING DAMAGE

- .1 While it is recognized that the maintenance contractor is not responsible for inspecting the site for general hazards, if any dangerous or potentially dangerous situations are observed then notification should be given at once, verbally, and where necessary in writing, to the Owner and to the appropriate public agencies or authorities responsible for the safety and repair of such property as public utilities or for protection of the environment

END OF SECTION

APPENDIX A: EXISTING SITE PHOTOS

Note:

All trailers, equipment, materials, and fencing have been removed from the site.

Site is cleared and leveled – no stockpiles remain.

Image taken October 22/23 2018



Photos taken on
October 30, 2018



Photos taken on
October 30, 2018



Photos taken on
November 3, 2018



Photos taken on
November 3, 2018



Photos taken on
November 3, 2018



APPENDIX B:
EXISTING GEOTECHNICAL SITE INFORMATION

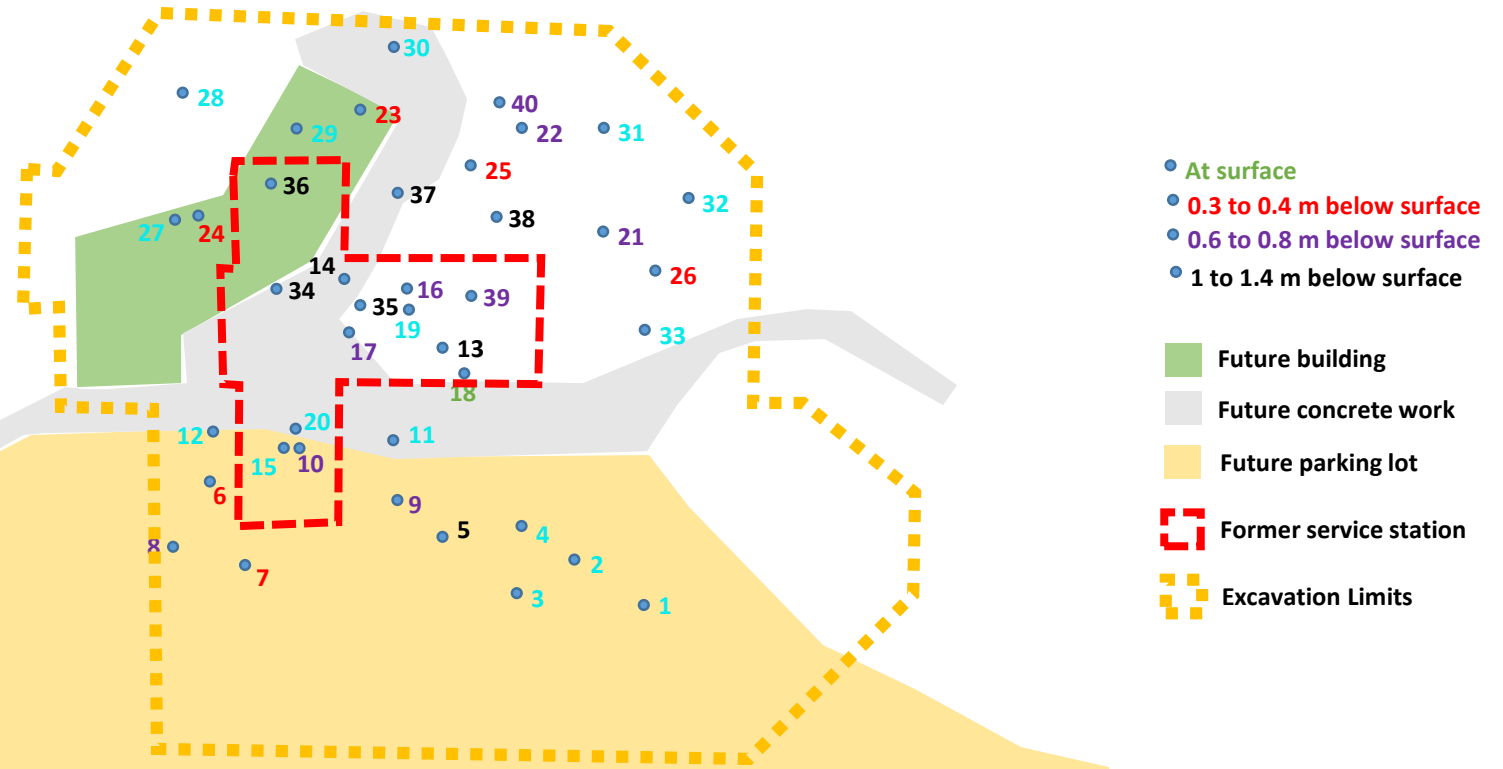
Compaction Test Results from Previous Excavation/Backfilling Work (numbers corresponding to Summary Table)

NOTE:

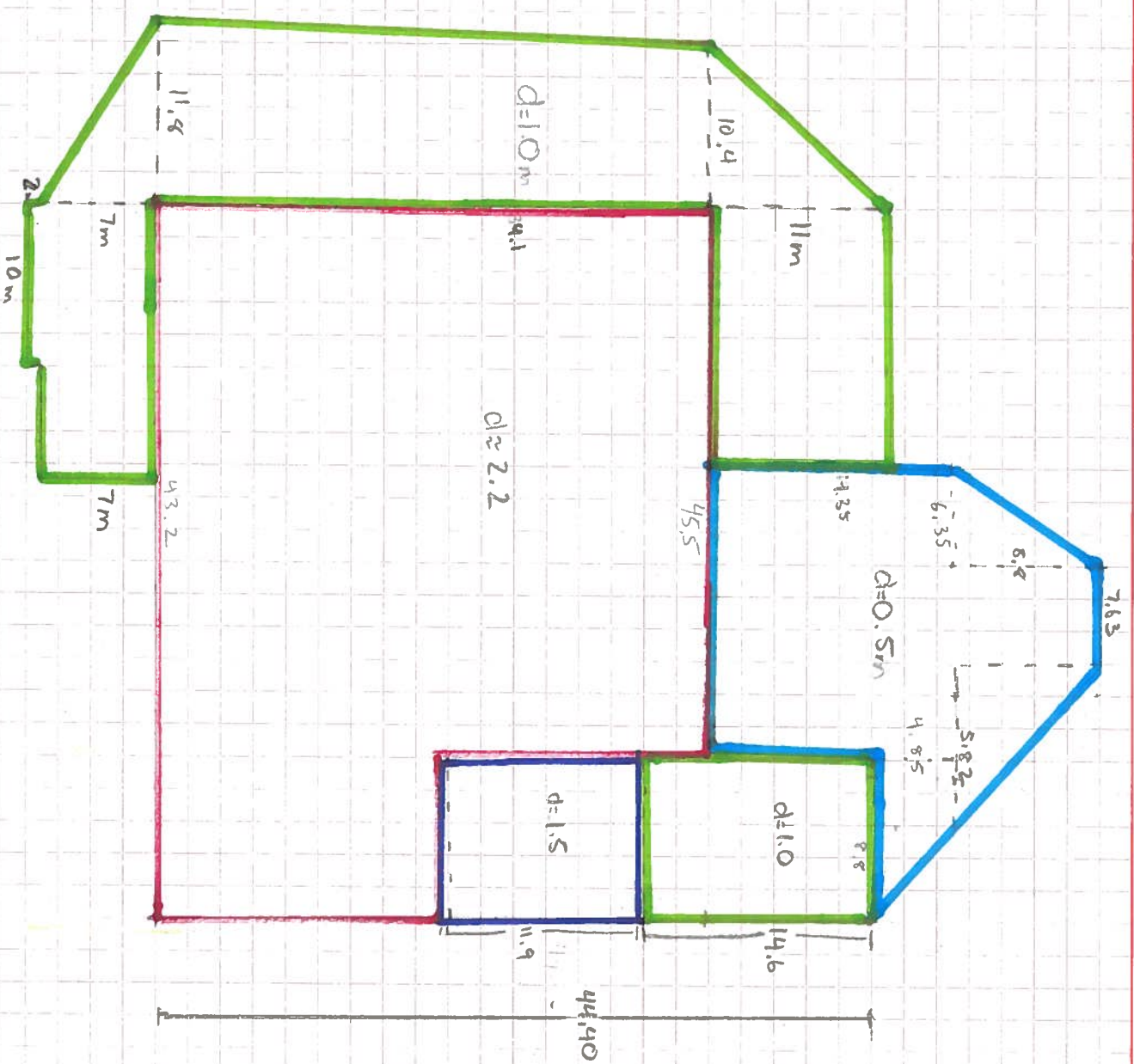
This Appendix outlines the extents of excavation and backfilling that was completed for a soil remediation project that occurred on the site in late October 2018.

Compaction values at various depths are outlined in the summary table and the following figures are meant to give the Contractor an idea on the extent of the previous work that was completed on site.

As indicated on the Contract Drawings there are some areas where the Contractor will need to re-excavate and backfill on the identified requirements.



Subject:



■ Depth $\approx 2.2\text{m}$

Depth = 13

Depth = 1.5 m

Depth = 0.5 m



ENGINEERING INC.

901 - 10th Street North, Golden, B.C. V0A 1H0
Phone: 250-939-9539 Fax: 604-948-9064

Field Density Report

**Client:** SECURE Energy (Onsite Services) Inc.

120, 8832 Blackfoot Trail SE,
Calgary AB, T2J 3J1

Attention: Mr. Stephen Gordon**Project:** Lodge, Service Station Abatement, Demolition and Remediation GNP**Project No:** 18-00000-070**Field Method:** Nuclear ASTM D6938**Laboratory Method:** ASTM D 698 Method C**Rock Correction Method:** ASTM D4718 Proctor Density

Correction Passing 3/4" - 19mm

Report No: 8**No. of Densities:** 5**Tested By:** DA**Date Tested:** October 6, 2018**Contractor:** Secure Energy**Location:** Glacier Park Lodge**Construction** Trench Backfill**Type:****Material Type:** Native

Density Number	Test Location	Reference	Moisture %		Oversize Material %	Dry Density		Compaction (%)
			Field	Optimum		Field	Lab	
1	Location 1 At Grade	Provided by Client	9.6	8.1	16	2076	2136	97
2	Location 2 At Grade	Provided by Client	10.1	8.1	16	2025	2136	95
3	Location 3 At Grade	Provided by Client	10.4	8.1	16	2068	2136	97
4	Location 4 At Grade	Provided by Client	10.5	8.1	16	2020	2136	95
5	Location 5 1.2m Below Grade	Provided by Client	10.1	8.1	16	2021	2136	95

Comments: Only compliant results shown, 4 retest(s) performed
Client informed of results

Specified Compaction: 95
Low Densities Indicated: 

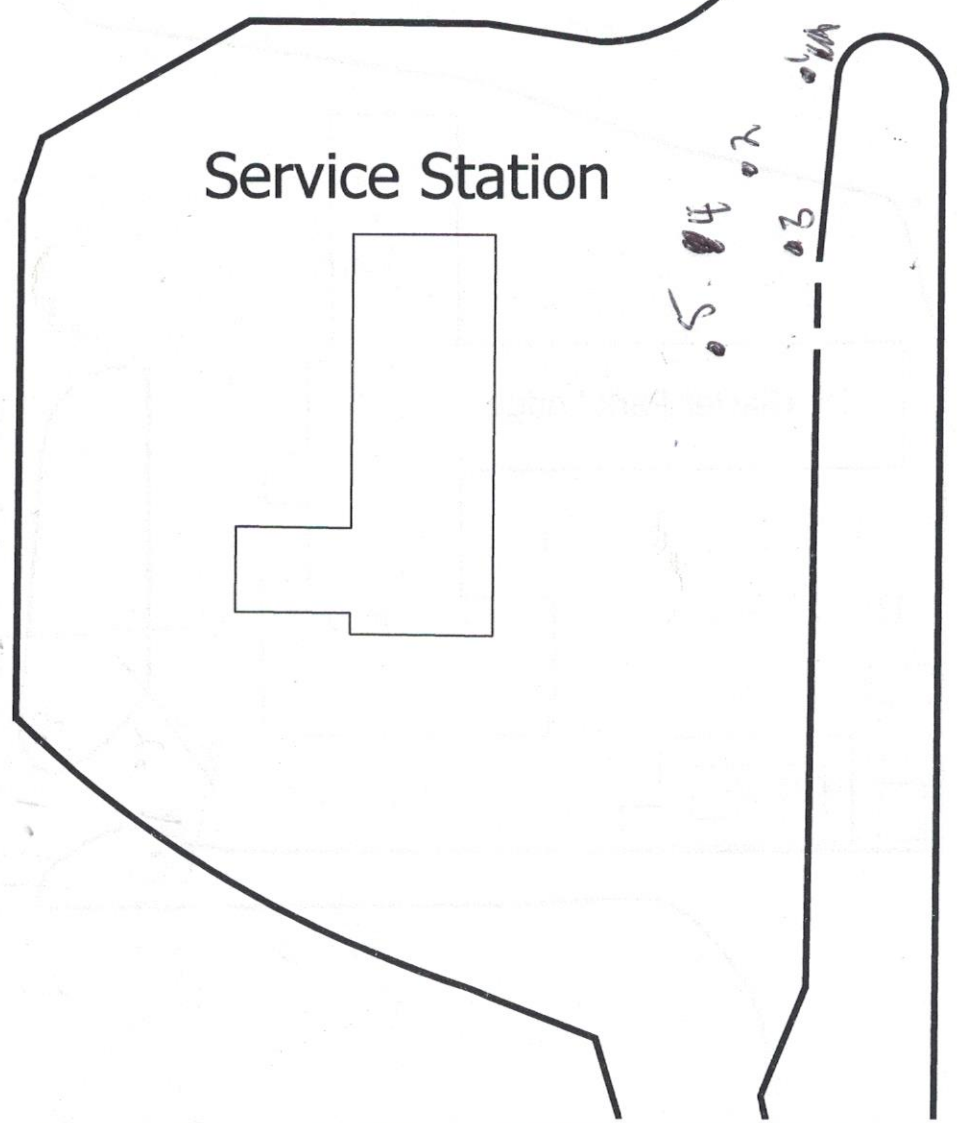



EXL Engineering Inc.

Per:

G. Lecuyer P.Eng. - Materials Engineer

21055430
 544000
 Oct 6, 2018
 Report #8



LEGEND	ADAPTED FROM		TITLE	
	N/A		Area 1, 1A, 2, and EX1 Sample Locations	
	DATE	PROJECT NO.	PROJECT	
	N/A	N/A	Tender Specifications	
This drawing is the sole property of WSP Canada Inc. and cannot be used or duplicated in any way without the expressed written consent of WSP. The general contractor shall verify all dimensions and report any discrepancies to WSP Canada Inc.	 108 - 3677 Hwy 97N Kelowna, BC V1X 5C3 p: 250-491-9778 f: 250-491-9729 www.wsp.com		ADDRESS	
			Rogers Pass West, BC	
			CLIENT	
			Parks Canada, Government of Canada	
DWN		CHK	SCALE	DATE
LTR		KZ	NTS	December 2017
PROJECT NO.			DRAWING NO.	
171-14310-00			FIGURE 3	

Client: **SECURE Energy (Onsite Services) Inc.**120, 8832 Blackfoot Trail SE,
Calgary AB, T2J 3J1Attention: **Mr. Stephen Gordon**Project: Lodge, Service Station Abatement, Demolition and Remediation GNP

Project No: 18-00000-070

Field Method: Nuclear ASTM D6938

Laboratory Method: ASTM D 698 Method C

Rock Correction Method: ASTM D4718 Proctor Density

Correction Passing 3/4" - 19mm

Report No: 9

No. of Densities: 7

Tested By: DA

Date Tested: October 7, 2018

Contractor: Secure Energy

Location: Service Station

Construction Type: Trench Backfill

Material Type: Native

Density Number	Test Location	Reference	Moisture %		Oversize Material %	Dry Density		Compaction (%)
			Field	Optimum		Field	Lab	
1	Location 1 0.3m Below Grade	Provided by Client	9.6	8.1	16	2116	2136	99
2	Location 2 0.3m Below Grade	Provided by Client	9.3	8.1	16	2082	2136	97
3	Location 3 0.8m Below Grade	Provided by Client	10.1	8.1	16	2019	2136	95
4	Location 4 0.6m Below Grade	Provided by Client	10.5	8.1	16	2041	2136	96
5	Location 5 0.6m Below Grade	Provided by Client	11.0	8.1	16	2027	2136	95

Comments: Only compliant results shown, 3 retest(s) performed
Client informed of resultsSpecified Compaction: 95
Low Densities Indicated:

EXL Engineering Inc.

Per:

G. Lecuyer P.Eng. - Materials Engineer



ENGINEERING INC.

901 - 10th Street North, Golden, B.C. V0A 1H0
Phone: 250-939-9539 Fax: 604-948-9064

Field Density Report



Client: SECURE Energy (Onsite Services) Inc.

120, 8832 Blackfoot Trail SE,
Calgary AB, T2J 3J1

Attention: Mr. Stephen Gordon

Project: Lodge, Service Station Abatement, Demolition and Remediation GNP

Project No: 18-00000-070

Field Method: Nuclear ASTM D6938

Laboratory Method: ASTM D 698 Method C

Rock Correction Method: ASTM D4718 Proctor Density

Correction Passing 3/4" - 19mm

Report No: 9

No. of Densities: 7

Tested By: DA

Date Tested: October 7, 2018

Contractor: Secure Energy

Location: Service Station

Construction Trench Backfill

Type:

Material Type: Native

Density Number	Test Location	Reference	Moisture %		Oversize Material %	Dry Density		Compaction (%)
			Field	Optimum		Field	Lab	
6	Location 6 At Grade	Provided by Client	10.4	8.1	16	2052	2136	96
7	Location 7 At Grade	Provided by Client	8.8	8.1	16	2110	2136	99

Comments: Only compliant results shown, 3 retest(s) performed
Client informed of results

Specified Compaction: 95
Low Densities Indicated:

G. Lecuyer

EXL Engineering Inc.

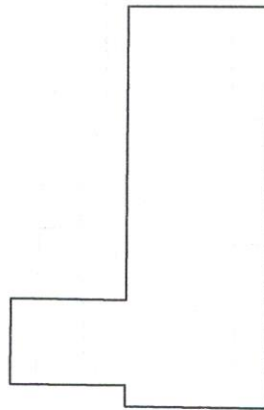
Per:

G. Lecuyer P.Eng. - Materials Engineer


OCT 7, 2018
Report #09



Service Station



Handwritten notes: 70.4, 50, 10, 20, 30

LEGEND	ADAPTED FROM		N/A		TITLE		Area 1, 1A, 2, and EX1 Sample Locations			
	DATE	PROJECT NO.			PROJECT		Tender Specifications			
	N/A	N/A			ADDRESS		Rogers Pass West, BC			
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		108 - 3677 Hwy 97N Kelowna, BC V1X 5C3 p: 250-491-9778 f: 250-491-9729 www.wsp.com		DWN	CHK	SCALE	DATE	PROJECT NO.	DRAWING NO.	
				LTR	KZ	NTS	December 2017	171-14310-00	FIGURE 3	



ENGINEERING INC.

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Phone: 250-939-9539 Fax: 604-948-9064

Field Density Report



Client: SECURE Energy (Onsite Services) Inc.

120, 8832 Blackfoot Trail SE,
Calgary AB, T2J 3J1

Attention: Mr. Stephen Gordon

Project: Lodge, Service Station Abatement, Demolition and Remediation GNP

Project No: 18-00000-070

Field Method: Nuclear ASTM D6938

Laboratory Method: ASTM D 698 Method C

Rock Correction Method: ASTM D4718 Proctor Density

Correction Passing 3/4" - 19mm

Report No: 10

No. of Densities: 5

Tested By: DA

Date Tested: October 8, 2018

Contractor: Secure Energy

Location: Service Station

Construction Trench Backfill

Type:

Material Type: Native

Density Number	Test Location	Reference	Moisture %		Oversize Material %	Dry Density		Compaction (%)
			Field	Optimum		Field	Lab	
1	Location 1 1.2m Below Top of Grade	Provided by Client	7.6	8.1	16	2099	2136	98
2	Location 2 1.2m Below Top of Grade	Provided by Client	12.6	8.1	16	2021	2136	95
3	Location 3 Top of Grade	Provided by Client	8.3	8.1	16	2035	2136	95
4	Location 4 0.7m Below Top of Grade	Provided by Client	7.9	8.1	16	2079	2136	97
5	Location 5 0.7m Below Top of Grade	Provided by Client	8.4	8.1	16	2023	2136	95

Comments: Only compliant results shown, 0 retest(s) performed
Client informed of results

Specified Compaction: 95
Low Densities Indicated: 

EXL Engineering Inc.

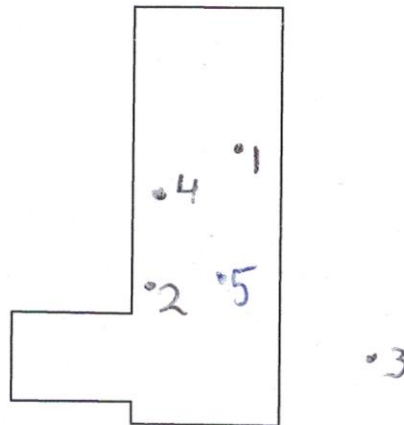
Per:

G. Lecuyer P.Eng. - Materials Engineer

Oct 8/18
Report # 710



Service Station



LEGEND	ADAPTED FROM		TITLE					
	N/A		Area 1, 1A, 2, and EX1 Sample Locations					
	DATE	PROJECT NO.	PROJECT					
	N/A	N/A	Tender Specifications					
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			Rogers Pass West, BC					
			CLIENT					
			Parks Canada, Government of Canada					
			DWN	CHK	SCALE	DATE	PROJECT NO.	DRAWING NO.
			LTR	KZ	NTS	December 2017	171-14310-00	FIGURE 3

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Phone: 250-939-9539 Fax: 604-948-9064

Field Density Report



Client: SECURE Energy (Onsite Services) Inc.

120, 8832 Blackfoot Trail SE,
Calgary AB, T2J 3J1

Attention: Mr. Stephen Gordon

Project: Lodge, Service Station Abatement, Demolition and Remediation GNP

Project No: 18-00000-070

Field Method: Nuclear ASTM D6938

Laboratory Method: ASTM D 698 Method C

Rock Correction Method: ASTM D4718 Proctor Density

Correction Passing 3/4" - 19mm

Report No: 11

No. of Densities: 3

Tested By: DA

Date Tested: October 9, 2018

Contractor: Secure Energy

Location: Service Station

Construction Trench Backfill

Type:

Material Type: Native

Density Number	Test Location	Reference	Moisture %		Oversize Material %	Dry Density		Compaction (%)
			Field	Optimum		Field	Lab	
1	Location 1 Top of Grade	Provided by Client	8.8	8.1	16	2057	2136	96
2	Location 2 Top of Grade	Provided by Client	11.5	8.1	16	2019	2136	95
3	Location 3 Top of Grade	Provided by Client	7.6	8.1	16	2035	2136	95

Comments: Only compliant results shown, 4 retest(s) performed
Client informed of results

Specified Compaction: 95
Low Densities Indicated: 

EXL Engineering Inc.

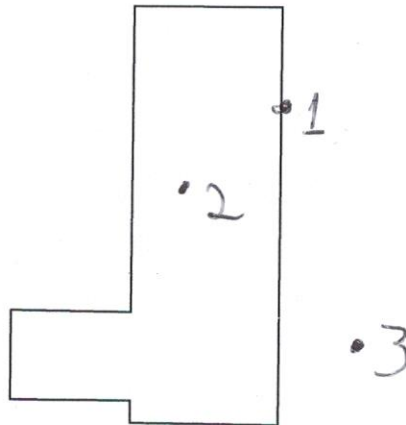
Per:

G. Lecuyer P.Eng. - Materials Engineer

Oct 9/18
Report #811



Service Station



LEGEND

ADAPTED FROM

N/A

DATE

N/A

PROJECT NO.

N/A

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TITLE

Area 1, 1A, 2, and EX1 Sample Locations

PROJECT

Tender Specifications

ADDRESS

Rogers Pass West, BC

CLIENT

Parks Canada, Government of Canada

DWN

LTR

CHK

KZ

SCALE

NTS

DATE

December 2017

PROJECT NO.

171-14310-00

DRAWING NO.

FIGURE 3



ENGINEERING INC.

901 - 10th Street North, Golden, B.C. V0A 1H0
Phone: 250-939-9539 Fax: 604-948-9064

Field Density Report



Client: SECURE Energy (Onsite Services) Inc.

120, 8832 Blackfoot Trail SE,
Calgary AB, T2J 3J1

Attention: Mr. Stephen Gordon

Project: Lodge, Service Station Abatement, Demolition and Remediation GNP

Project No: 18-00000-070

Field Method: Nuclear ASTM D6938

Laboratory Method: ASTM D 698 Method C

Rock Correction Method: ASTM D4718 Proctor Density

Correction Passing 3/4" - 19mm

Report No: 12

No. of Densities: 10

Tested By: DA

Date Tested: October 19, 2018

Contractor: Secure Energy

Location: Service Station

Construction Backfill

Type:

Material Type: Native

Density Number	Test Location	Reference	Moisture %		Oversize Material %	Dry Density		Compaction (%)
			Field	Optimum		Field	Lab	
1	Location 1 1.4m below grade	Provided by Client	11.5	8.1	16	2031	2136	95
2	Location 2 1.4m below grade	Provided by Client	10.0	8.1	16	2019	2136	95
3	Location 3 1.0m below grade	Provided by Client	8.8	8.1	16	2086	2136	98
4	Location 4 1.0m below grade	Provided by Client	8.9	8.1	16	2069	2136	97
5	Location 5 1.4m below grade	Provided by Client	9.4	8.1	16	2029	2136	95

Comments: Only compliant results shown, 4 retest(s) performed
Client informed of results

Specified Compaction: 95
Low Densities Indicated:

G. Lecuyer

EXL Engineering Inc.

Per:

G. Lecuyer P.Eng. - Materials Engineer

**Client:** SECURE Energy (Onsite Services) Inc.120, 8832 Blackfoot Trail SE,
Calgary AB, T2J 3J1**Attention:** Mr. Stephen Gordon**Project:** Lodge, Service Station Abatement, Demolition and Remediation GNP**Project No:** 18-00000-070**Field Method:** Nuclear ASTM D6938**Laboratory Method:** ASTM D 698 Method C**Rock Correction Method:** ASTM D4718 Proctor Density

Correction Passing 3/4" - 19mm

Report No: 12**No. of Densities:** 10**Tested By:** DA**Date Tested:** October 19, 2018**Contractor:** Secure Energy**Location:** Service Station**Construction** Backfill**Type:****Material Type:** Native

Density Number	Test Location	Reference	Moisture %		Oversize Material %	Dry Density		Compaction (%)
			Field	Optimum		Field	Lab	
6	Location 6 0.8m below grade	Provided by Client	7.7	8.1	16	2039	2136	95
7	Location 7 0.8m below grade	Provided by Client	7.5	8.1	16	2022	2136	95
8	Location 8 0.2m below grade	Provided by Client	8.3	8.1	16	2023	2136	95
9	Location 9 0.2m below grade	Provided by Client	9.2	8.1	16	2065	2136	97
10	Location 10 0.2m below grade	Provided by Client	7.7	8.1	16	2028	2136	95

Comments: Only compliant results shown, 0 retest(s) performed
Client informed of results**Specified Compaction:** 95
Low Densities Indicated:

EXL Engineering Inc.

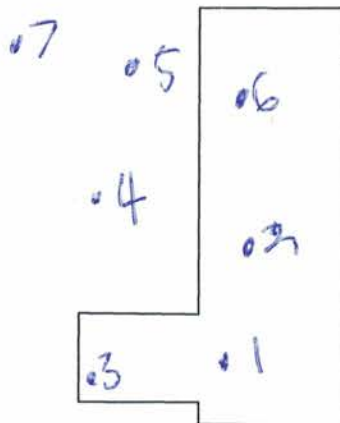
Per:

G. Lecuyer P.Eng. - Materials Engineer

Report 12 locations



Service Station



LEGEND

ADAPTED FROM

N/A

DATE

N/A

PROJECT NO.

N/A

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108 - 3677 Hwy 97N
Kelowna, BC V1X 5C3
p: 250-491-9778
f: 250-491-9729
www.wsp.com

TITLE

Area 1, 1A, 2, and EX1 Sample Locations

PROJECT

Tender Specifications

ADDRESS

Rogers Pass West, BC

CLIENT

Parks Canada, Government of Canada

DWN

LTR

CHK

KZ

SCALE

NTS

DATE

December 2017

PROJECT NO.

171-14310-00

DRAWING NO.

FIGURE 3



ENGINEERING INC.

901 - 10th Street North, Golden, B.C. V0A 1H0
Phone: 250-939-9539 Fax: 604-948-9064

Field Density Report

**Client:** SECURE Energy (Onsite Services) Inc.

120, 8832 Blackfoot Trail SE,
Calgary AB, T2J 3J1

Attention: Mr. Stephen Gordon**Project:** Lodge, Service Station Abatement, Demolition and Remediation GNP**Project No:** 18-00000-070**Field Method:** Nuclear ASTM D6938**Laboratory Method:** ASTM D 698 Method C**Rock Correction Method:** ASTM D4718 Proctor Density

Correction Passing 3/4" - 19mm

Report No: 13**No. of Densities:** 13**Tested By:** DA**Date Tested:** October 25, 2018**Contractor:** Secure Energy**Location:** Service Station**Construction** Backfill**Type:****Material Type:** Native

Density Number	Test Location	Reference	Moisture %		Oversize Material %	Dry Density		Compaction (%)
			Field	Optimum		Field	Lab	
1	Location 1 0.7m below grade	Provided by Client	10.1	8.1	16	2049	2136	96
2	Location 2 0.7m below grade	Provided by Client	10.8	8.1	16	2111	2136	99
3	Location 3 0.4m below grade	Provided by Client	9.2	8.1	16	2108	2136	99
4	Location 4 0.4m below grade	Provided by Client	11.3	8.1	16	2068	2136	97
5	Location 5 0.4m below grade	Provided by Client	7.8	8.1	16	2140	2136	100

Comments: Only compliant results shown, 4 retest(s) performed
Client informed of results

Specified Compaction: 95
Low Densities Indicated: 



EXL Engineering Inc.

Per:

G. Lecuyer P.Eng. - Materials Engineer

**Client:** SECURE Energy (Onsite Services) Inc.120, 8832 Blackfoot Trail SE,
Calgary AB, T2J 3J1**Attention:** Mr. Stephen Gordon**Project:** Lodge, Service Station Abatement, Demolition and Remediation GNP**Project No:** 18-00000-070**Field Method:** Nuclear ASTM D6938**Laboratory Method:** ASTM D 698 Method C**Rock Correction Method:** ASTM D4718 Proctor Density

Correction Passing 3/4" - 19mm

Report No: 13**No. of Densities:** 13**Tested By:** DA**Date Tested:** October 25, 2018**Contractor:** Secure Energy**Location:** Service Station**Construction** Backfill**Type:****Material Type:** Native

Density Number	Test Location	Reference	Moisture %		Oversize Material %	Dry Density		Compaction (%)
			Field	Optimum		Field	Lab	
6	Location 6 0.4m below grade	Provided by Client	8.3	8.1	16	2061	2136	96
7	Location 7 At grade	Provided by Client	10.1	8.1	16	2060	2136	96
8	Location 8 At grade	Provided by Client	9.8	8.1	16	2072	2136	97
9	Location 9 At grade	Provided by Client	10.9	8.1	16	2048	2136	96
10	Location 10 At grade	Provided by Client	11.5	8.1	16	2035	2136	95

Comments: Only compliant results shown, 0 retest(s) performed
Client informed of results**Specified Compaction:** 95
Low Densities Indicated:

EXL Engineering Inc.

Per:

G. Lecuyer P.Eng. - Materials Engineer



ENGINEERING INC.

901 - 10th Street North, Golden, B.C. V0A 1H0
Phone: 250-939-9539 Fax: 604-948-9064

Field Density Report



Client: SECURE Energy (Onsite Services) Inc.

120, 8832 Blackfoot Trail SE,
Calgary AB, T2J 3J1

Attention: Mr. Stephen Gordon

Project: Lodge, Service Station Abatement, Demolition and Remediation GNP

Project No: 18-00000-070

Field Method: Nuclear ASTM D6938

Laboratory Method: ASTM D 698 Method C

Rock Correction Method: ASTM D4718 Proctor Density

Correction Passing 3/4" - 19mm

Report No: 13

No. of Densities: 13

Tested By: DA

Date Tested: October 25, 2018

Contractor: Secure Energy

Location: Service Station

Construction Backfill

Type:

Material Type: Native

Density Number	Test Location	Reference	Moisture %		Oversize Material %	Dry Density		Compaction (%)
			Field	Optimum		Field	Lab	
11	Location 11 At grade	Provided by Client	7.5	8.1	16	2166	2136	101
12	Location 12 At grade	Provided by Client	11.5	8.1	16	2062	2136	97
13	Location 13 At grade	Provided by Client	9.5	8.1	16	2046	2136	96

Comments: Only compliant results shown, 0 retest(s) performed
Client informed of results

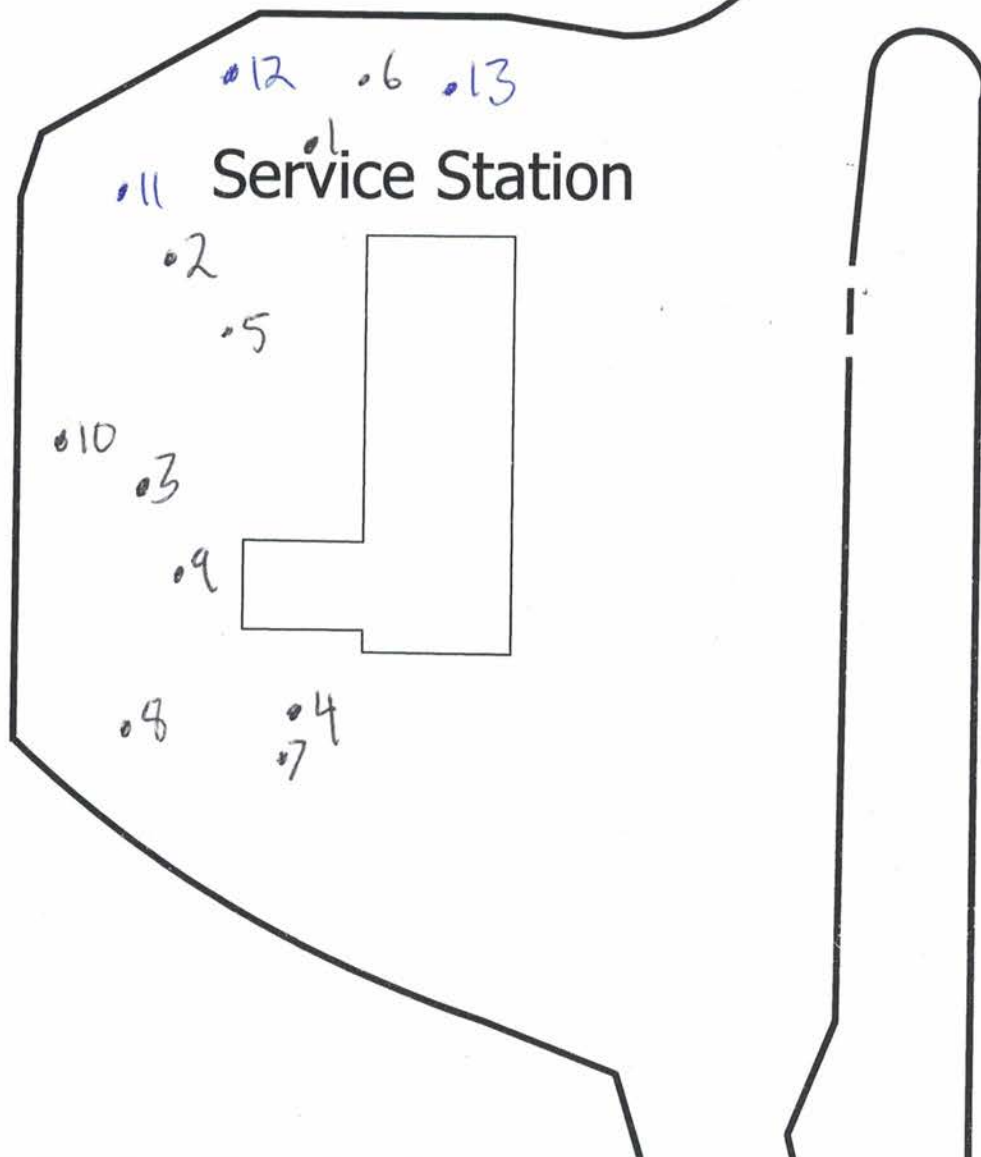
Specified Compaction: 95
Low Densities Indicated: 


EXL Engineering Inc.

Per:

G. Lecuyer P.Eng. - Materials Engineer

Report 13 Locations



LEGEND	ADAPTED FROM		N/A		 <p>108 - 3677 Hwy 97N Kelowna, BC V1X 5C3 p: 250-491-9778 f: 250-491-9729 www.wsp.com</p>	TITLE Area 1, 1A, 2, and EX1 Sample Locations					
	DATE		PROJECT NO.			PROJECT Tender Specifications					
	N/A		N/A			ADDRESS Rogers Pass West, BC					
	<small>This drawing is the sole property of WSP Canada Inc. and cannot be used or duplicated in any way without the express written consent of WSP. The general contractor shall verify all dimensions and report any discrepancies to WSP Canada Inc.</small>					CLIENT Parks Canada, Government of Canada					
DWG		CHK		SCALE		DATE		PROJECT NO.		DRAWING NO.	
LTR		KZ		NTS		December 2017		171-14310-00		FIGURE 3	

SUMMARY OF COMPACTION TEST RESULTS FROM EXL ENGINEERING							
Refer to individual reports attached for more information							
Field Method:		Nuclear ASTM D6938					
Laboratory Method:		ASTM D 698 Method C					
Rock Correction Method:		ASTM D4718 Proctor Density, Correction Passing 3/4" - 19mm					
Location	Date	Depth (m)	Moisture %		Oversize Material %	Dry Density	
			Field	Optimum		Field	Lab
1	Oct-06	at grade	9.6	8.1	16	2076	2136
2	Oct-06	at grade	10.1	8.1	16	2025	2136
3	Oct-06	at grade	10.4	8.1	16	2068	2136
4	Oct-06	at grade	10.5	8.1	16	2020	2136
5	Oct-06	1.2 m below	10.1	8.1	16	2021	2136
6	Oct-07	0.3 m below	9.6	8.1	16	2116	2136
7	Oct-07	0.3 m below	9.3	8.1	16	2082	2136
8	Oct-07	0.8 m below	10.1	8.1	16	2019	2136
9	Oct-07	0.6 m below	10.5	8.1	16	2041	2136
10	Oct-07	0.6 m below	11	8.1	16	2027	2136
11	Oct-07	at grade	10.4	8.1	16	2052	2136
12	Oct-07	at grade	8.8	8.1	16	2110	2136
13	Oct-08	1.2 m below	7.6	8.1	16	2099	2136
14	Oct-08	1.2 m below	12.6	8.1	16	2021	2136
15	Oct-08	at grade	8.3	8.1	16	2035	2136
16	Oct-08	0.7 m below	7.9	8.1	16	2079	2136
17	Oct-08	0.7 m below	8.4	8.1	16	2023	2136
18	Oct-09	at grade	8.8	8.1	16	2057	2136
19	Oct-09	at grade	11.5	8.1	16	2019	2136
20	Oct-09	at grade	7.6	8.1	16	2035	2136
21	Oct-25	0.7 m below	10.1	8.1	16	2049	2136
22	Oct-25	0.7 m below	10.8	8.1	16	2111	2136
23	Oct-25	0.4 m below	9.2	8.1	16	2108	2136
24	Oct-25	0.4 m below	11.3	8.1	16	2068	2136
25	Oct-25	0.4 m below	7.8	8.1	16	2140	2136
26	Oct-25	0.4 m below	8.3	8.1	16	2061	2136
27	Oct-25	at grade	10.1	8.1	16	2060	2136
28	Oct-25	at grade	9.8	8.1	16	2072	2136
29	Oct-25	at grade	10.9	8.1	16	2048	2136
30	Oct-25	at grade	11.5	8.1	16	2035	2136
31	Oct-25	at grade	7.5	8.1	16	2166	2136
32	Oct-25	at grade	11.5	8.1	16	2062	2136
33	Oct-25	at grade	9.5	8.1	16	2046	2136
34	Oct-19	1.4 m below	11.5	8.1	16	2031	2136
35	Oct-19	1.4 m below	10	8.1	16	2019	2136
36	Oct-19	1.0 m below	8.8	8.1	16	2086	2136
37	Oct-19	1.0 m below	8.9	8.1	16	2069	2136
38	Oct-19	1.4 m below	9.4	8.1	16	2029	2136
39	Oct-19	0.8 m below	7.7	8.1	16	2039	2136
40	Oct-19	0.8 m below	7.5	8.1	16	2022	2136

Compaction (%)
97
95
97
95
95
99
97
95
96
95
96
99
98
95
95
97
95
96
95
95
96
99
99
97
100
96
96
97
96
95
101
97
96
95
95
98
97
95
95
95

Summary by Depth

Depth	Average Compaction %	Average Moisture %
at grade	96	9.8
0.3 to 0.4	98	9.3
0.6 to 0.8	96	9.3
1 to 1.4	96	9.9